A revision of the Neotropical wasp genus *Trigonopsis* Perty (Hymenoptera : Sphecidae)

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Contents

Synopsis

Keys are provided to the sixteen species of *Trigonopsis* Perty here recognized, of which eight are described as new. Two specific names are newly placed in synonymy. The species are placed in four species-groups, one of which consists entirely of newly described species. Previously published information on biology is summarized, and further biological observations are added where possible.

Introduction

The wasps of the genus *Trigonopsis* are uncommonly encountered inhabitants of the New World tropical forests. They are strikingly elegant creatures, very elongate with a triangular, prognathous head, petiolate gaster, and most parts highly polished. The mandibles are also long and slender, well-adapted to catching and carrying the cockroach prey, which are stored in mud nests. These wasps are scarce in collections, since most collectors have tended to avoid forest habitats with their relatively low yields of insects.

Several species were described by various early authors, notably Smith (1851; 1856; 1873), usually on the basis of single specimens. Kohl (1902) first revised the genus, treating it as a subgenus of *Podium*. Since he did not see Smith's types, misunderstood the descriptions, and in most cases saw no other material assignable to Smith's species, he placed in synonymy several names since regarded as valid. He also confused other species and was misled by inaccurately labelled specimens.

Richards' (1937) revision was more limited in scope, since its main purpose was to provide names for the specimens collected during an expedition to Guyana. However, it also included the material already in the collections of the British Museum (Natural History), where most of Smith's types are housed. Richards, combining this advantage with a more critical approach, clarified much of the previous confusion.

Menke *in* Bohart & Menke (1976), in the context of a revision of sphecid genera, divided *Trigonopsis* into the *rufiventris* and *intermedia* species-groups, and stated that the latter is the more generalized of the two. However, the present study attempts to show that the *intermedia*-group as defined by Menke is more conveniently treated as three distinct groups. Nomenclature in the genus was also updated.

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Examination of recently acquired material in the British Museum (Natural History), using Richards' (1937) paper, indicated that undescribed species were represented. It also became evident that some characters, especially those of the female mandibles and male genitalia, had never received sufficient attention from any author. These facts together stimulated the present work.

Due mainly to lack of material, no previous author was in a position to assess the proximity of species and the extreme variation within some of them. In particular, the absence of the opposite sexes of many species frequently gave rise to misassociations of those present, and to other misidentifications. Considerable efforts were therefore made to gather together all available material, and a very wide range of characters was assessed. In addition, several sex associations were confirmed by reared specimens. As a result, a foundation has been laid for the detailed evaluation of supraspecific relationships here attempted. A high proportion of new species is described within this framework, with very few sexes remaining unknown. The *intermedia*-group of Menke *in* Bohart & Menke (1976) is here divided into three, including a species-group consisting entirely of newly described species.

Certain body measurements, and some ratios derived from them, proved to be of value in separating species. Measurements were made on most specimens with the exception of the numerous specimens of *violascens*, *rufiventris* and *cameronii*, of which samples were subjectively selected.

All measurements in the keys and descriptions are in millimetres, and ratios are expressed as an index derived from the division of one measurement by another. They are abbreviated as follows.

BL	Body length, excluding appendages.
Notch	Female mandible always has a notch of varying size and shape in the inner margin or on the inner side, nearer apex than base.
MBL	Mandibular base length. From notch to base of eye.
MAL	Mandibular apex length. From notch to tip.
MR	Mandibular ratio. MBL divided by MAL. (When the mandible is very worn, the abnormally high MR resulting is given in brackets after the normal range.)
CTW	Clypeal tooth width. In the females the distance between the tips of the outermost clypeal teeth. (Most males have only 2 teeth, or the clypeus is distinct.)
CED	Clypeal emargination depth. Perpendicular distance from the base of the central emargination to the line joining the tips of the teeth (males only).
TOD	Tooth to orbit distance. From the tip of a tooth used to measure CTW, to the nearest point of an orbit.
CR	Clypeal ratio. CTW divided by TOD.
CER	Clypeal emargination ratio. CTW divided by CED (males only).
HW	Head width. Maximum, including eyes.
HL	Head length. From the base of a tooth nearest centre of clypeus, to posterior edge of occipital carina.
HR	Head ratio. HW divided by HL.
LIW	Lower interocular width. Least distance between lower orbits.
MIW	Middle interocular width. Greatest distance between middle orbits.
UIW	Upper interocular width. Least distance between upper orbits.
EL	Eye length.
PDL	Propodeal dorsal length.
PL	Petiole length. Distance from the apex of the propodeal valve to the junction with tergite 1.
PR	Petiole ratio. PL divided by PDL.

Material studied in the present work is deposited in the institutions abbreviated as follows.

AMNH, New York	American Museum of Natural History, New York.
ANS, Philadelphia	Academy of Natural Sciences, Philadelphia.
BMNH	British Museum (Natural History), London.
BPBM, Honolulu	Bernice P. Bishop Museum, Honolulu.
CM, Pittsburgh	Carnegie Museum, Pittsburgh.
CMNH, Los Angeles	County Museum of Natural History, Los Angeles.
CNC, Ottawa	Canadian National Collection, Ottawa.
CU, Davis	California University, Davis.

CU, Ithaca	Cornell University, Ithaca, New York.
Fritz coll.	Personal collection of M. A. Fritz, Instituto Entomológico San Miguel, San Miguel, Province of Buenos Aires.
FSAE, Gembloux	Faculté des Sciences Agronomique de l'État, Gembloux, Belgium.
IML, Tucumán	Instituto Miguel Lillo, Tucumán, Argentina.
IRSNB, Brussels	Institut Royal des Sciences Naturelles de Belgique, Brussels.
IZA, Maracay	Instituto de Zoología Agrícola, Maracay, Venezuela.
MCZ, Harvard	Museum of Comparative Zoology, Harvard.
Menke coll.	Personal collection of Dr A. S. Menke, U.S. Dept of Agriculture, c/o U.S. National Museum, Washington.
MHN, Geneva	Muséum d'Histoire Naturelle, Geneva.
MIZSU, Turin	Museo ed Istituto di Zoología Sistematica dell'Università, Turin.
MNHN, Paris	Muséum National d'Histoire Naturelle, Paris
MNHU, Berlin	Museum für Naturkunde der Humboldt-Universität, Berlin.
MP, Belém	Museu Paraense Emilio Goeldi, Belém, Pará, Brazil.
NM, Rotterdam	Natuurhistorisch Museum, Rotterdam.
NM, Vienna	Naturhistorisches Museum, Vienna.
NR, Stockholm	Naturhistoriska Riksmuseum, Stockholm.
RNH, Leiden	Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands.
TM, Budapest	Természettudományi Múzeum, Budapest.
UM, Oxford	University Museum, Oxford
USNM, Washington	United States National Museum, Washington, D.C.
UZM, Copenhagen	University Zoological Museum, Copenhagen.
ZSBS, Munich	Zoologische Sammlung des Bayerischen Staates, Munich.

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TRIGONOPSIS Perty

Trigonopsis Perty, 1833 : 141, pl. 27, fig. 18. Type-species: *Trigonopsis abdominalis* Perty, 1833 (= ***Podium rufiventre*** Fabricius, 1804), by monotypy.
Trigonopsis Perty; Smith, 1851 : 31; 1856 : 226, pl. 6, fig. 1; 1873 : 54.
Trigonopsis Perty [as subgenus of *Podium* Fabricius]; Kohl, 1902 : 2.
Trigonopsis Perty; Williams, 1928 : 114.
Trigonopsis Perty; Richards, 1937 : 107.
Trigonopsis Perty; Menke *in* Bohart & Menke, 1976 : 96.

The following description is largely based on that given by Menke *in* Bohart & Menke (1976 : 96–97), with certain modifications.

Highly polished wasps 13–26 mm long, black with red gaster or entirely metallic blue-violet. Forewing hyaline or slightly infuscate with 2 dark, transverse bands towards apex. Head large, ± triangular, strongly prognathous. Occipital carina sometimes expanded into a flange. Mandible long and slender, especially in females, in which its inner margin always has a notch of varying size and shape near the apex, and usually also a basal spine. Some males have a sub-basal tooth on the mandibular inner margin. Female clypeus with 4–7 marginal teeth, male with 2 or structure quite different. Some males have subclypeal tubercles. Antennae cylindrical, sometimes flattened or expanded in males. Pronotum ± elongate, often with a dorsal projection. Mesopleuron with complete episternal sulcus. Propodeum with spiracular groove, its dorsum (= metapostnotum) with a longitudinal groove containing a carina and strong transverse rugae. Remainder of dorsum with or without transverse rugae. Gaster with long petiole.

Among the Sphecinae, *Trigonopsis* is easily distinguished by its elongate shape, prognathous head and typical colour patterns, especially of the wing-bands. These characters are shared by only a few of the species of *Podium* Fabricius and *Penepodium* Menke, its closest relatives (these two genera are hereinafter referred to as *Podium* s.l.). *Trigonopsis* is distinguished from these genera by its propodeal dorsal groove containing a carina and transverse rugae (at most a shallow, simple groove in *Podium* s.l.), the spiracular groove (absent in *Podium* s.l.) and the complete episternal sulcus (incomplete below in *Podium* s.l.). In addition, the female of *Trigonopsis* always has a mandibular notch (although vestigial in one species, it is never absent), and the cuspis of the male genitalia has a basal post (Fig. 70). Both notch and post are lacking in *Podium* s.l.

THE SPECIES-GROUPS. Sixteen species are recognized. Since the key is artificial, it does not reflect the four natural groups in which these are placed. They are characterized and inter-related as follows.

rufiventris-group
- ***violascens*** (Dalla Torre)
  - *violaceus* Smith
  - *resplendens* (Kohl) **syn. n.**
- ***menkei*** **sp. n.**
- ***rufiventris*** (Fabricius)
  - *abdominalis* Perty
  - *haemorrhoidalis* Smith
  - *soror* Mocsary **syn. n.**
  - *frivaldskyi* Mocsary
- ***cameronii*** (Kohl)
- ***howesi*** **sp. n.**
- ***grylloctonus*** Richards

vicina-group
- ***richardsi*** **sp. n.**
- ***vicina*** (Dalla Torre)
  - *affinis* Smith
- ***schunkei*** **sp. n.**

intermedia-group
- ***intermedia*** Saussure
- ***cyclocephalus*** Smith
- ***moraballi*** Richards

neotropica-group
- ***neotropica*** **sp. n.**
- ***succinea*** **sp. n.**
- ***mocoana*** **sp. n.**
- ***cooperi*** **sp. n.**

The ***rufiventris***-group. Propodeal dorsum with, at most, traces of rugae outside central furrow. ♂ sternite 8 bifid, genitalia distinctive, basal post of cuspis round-ended. ♀ clypeus with 5 ± regular teeth, mandible with V-shaped notch. ♂ without subclypeal tubercles, antennae cylindrical.

The ***vicina***-group. Propodeal dorsum with rugae outside central furrow. ♂ sternite 8 entire, basal post of cuspis round-ended. ♀ clypeus with 4–5 regular teeth, mandible with U- to V-shaped notch. ♂ with subclypeal tubercles and flattened, ± expanded antennae.

The ***intermedia***-group. Propodeal dorsum with rugae outside central furrow. ♂ sternite 8 entire, basal post of cuspis round-ended. ♀ clypeus with 6–7 often irregular teeth, mandible with U-shaped notch. ♂ without subclypeal tubercles, with cylindrical antennae.

The ***neotropica***-group. Propodeal dorsum with rugae outside central furrow. ♂ sternite 8 entire, basal post of cuspis square-ended. ♀ clypeus with 5 sometimes irregular teeth, mandible with step-like notch. ♂ sometimes with subclypeal tubercles, and usually slightly flattened antennae.

The *vicina*-group shows certain characters in common with all other groups of the genus. The clypeal and mandibular shape of female *richardsi*, the occipital flange of both its sexes, and the HR of 1·0 of female *richardsi* and all *vicina*-group males, are characters otherwise typical of the *rufiventris*-group.

The females of *vicina* and *schunkei*, the other two species of the *vicina*-group, have the mandibles strongly resembling those of all the *intermedia*-group females. These two groups are further linked by the males of *intermedia* and *schunkei*, the only two in the genus which have a sub-basal tooth on the mandibular inner margin. They are also the largest species of their respective groups.

The subclypeal tubercles found in all *vicina*-group males are also present in the *neotropica*-group, in the male of *neotropica* itself. The strong flattening and partial expansion of the antennae in all *vicina*-group males is paralleled by the slight flattening found in all known *neotropica*-group males except that of *cooperi*. The unusually dense pubescence of the anterior mesoscutum is found in several species of both groups, but not usually in both sexes of any one species. The first two characters are also found in certain species of *Podium* and *Penepodium*, which may indicate that they are ancestral.

Distribution. Most species of this genus are confined to lowland forest, a few ascending to between 600 and 1000 m. The range extends from Mexico to west-coast Ecuador, and everywhere east of the Andes south to Bolivia, the Mato Grosso and Rio de Janeiro.

Variation. The back of the head is sometimes greatly expanded, at times almost quadrate. This appears to be purely individual variation and is found in all species-groups. It occurs mainly in larger specimens and is more common in males than in females.

In addition, various structures show variation along two clines. From the east, one can be traced north-west into the Guianas, the other west along the Amazon. The latter is also accompanied by a colour cline. The Guianas are relatively isolated by high mountains to the south and west. Several species are so far known only from this area. The Andes form the western limit of distribution for all the Amazon Basin species.

The structural clines are most marked in *violascens*, *neotropica* and *cooperi*; details are given under those species.

Colour variation is most easily observed in *rufiventris* as it is the most widespread and commonly collected species of the genus. Almost all the specimens from eastern Brazil and the Guianas are very dark, becoming paler on average westwards along the Amazon. The red colour changes to orange and becomes more extensive, and the wings assume a strong amber tint. West of about 68° W., extreme, pale specimens occur (= *soror* Mocsary). All the females from Chanchamayo, Perené, Tapiche, Pebas, Iquitos and São Paulo de Olivença belong to this form. It is interesting that it seems to occur in isolation, since less extreme forms are unknown from these localities. There are reasonably long series from Mocoa and Pucallpa which show a good range of colour variation, but do not include the extreme form. The phenomenon affects other species in different localities. For example, a female *richardsi* from Satipo represents the extreme, pale form, while a female *rufiventris* from the same locality does not.

The females of all the red-and-black species show the same general tendency to become paler westwards along the Amazon, but to differing degrees. In *cooperi*, for example, the tendency is already strongly evident at 55° W., but not until further west in other species. Although males follow the same general trend, they are darker on average, and extreme, pale forms are unknown.

Biology. Eberhard (1972) noted interactions between individuals of *cameronii* while they were provisioning nests. This is of particular interest in that the behaviour may be described as subsocial. With reference to the same species, Eberhard (1974) gave the most comprehensive account of biology in the genus, including comparisons with certain species of other genera.

So far as is known, all species of *Trigonopsis* prey on cockroaches (apparently usually nymphs) except for *grylloctonus* and *rufiventris*, reported to prey on crickets (Richards, 1937 : 111, and the present study, p. 134). The prey are stored in cells made of mud, several in each cell. Nests consist of one to many cells and are attached to a great variety of forest substrates above ground level, of various degrees of stability. Usually only small nests are found under leaves, so that larger species tend not to choose such places. However, when smaller species choose firmer sites such as rock-faces, they usually make much larger nests than otherwise. On rock-face and tree-trunk sites, large numbers of cells often agglomerate and old ones are frequently renovated for re-use. Variation in the surface structure of mud added after the cells are completed may possibly serve the purpose of camouflage. The cell axes are always parallel and normally horizontal, those recorded by Richards (1937 : 109–110) being exceptional. Up to 4 cells may be placed in a single row but they form a bundle if more numerous. Further collecting is desirable to establish how the size and structure of nests varies according to species, site and region. At least some species belonging to different groups have differently shaped cocoons (Figs 36–39).

FUNCTIONAL MORPHOLOGY. Eberhard (1974 : 304–307) has already suggested how the clypeus and mandibles interact when *cameronii* catches and carries its prey. The sharp sides of the cockroach prey are well gripped during capture by the mandibular notches of the female wasp. Subsequently, these notches oppose the clypeal tooth gaps to grip the palpi of the prey, and prevent it slipping forwards or backwards between the wasp's legs, which hold it during the flight to the nest. A comparison of different species and species-groups reveals interesting compensations. The clypeal teeth of the *intermedia*-group species are usually very blunt and irregular, but the mandibles have broad notches and are the stoutest in the genus. However, most species of the *rufiventris*-group have very long, sharp, clypeal teeth, and mandibles with a strong expansion before a narrow notch, whose effect is further enhanced by the sharp bend of the mandible around it. The clypeal teeth of *violascens* are more variable and often less sharp, but the mandibular expansion is distinctly angulate. Related genera, which never have a mandibular notch, solve the problem of grip in two ways. *Podium* females have slender mandibles but many clypeal teeth, while those of *Penepodium* usually have stouter mandibles, which are angulate below, and only 2 clypeal teeth. (See also *rufiventris*-group notes.)

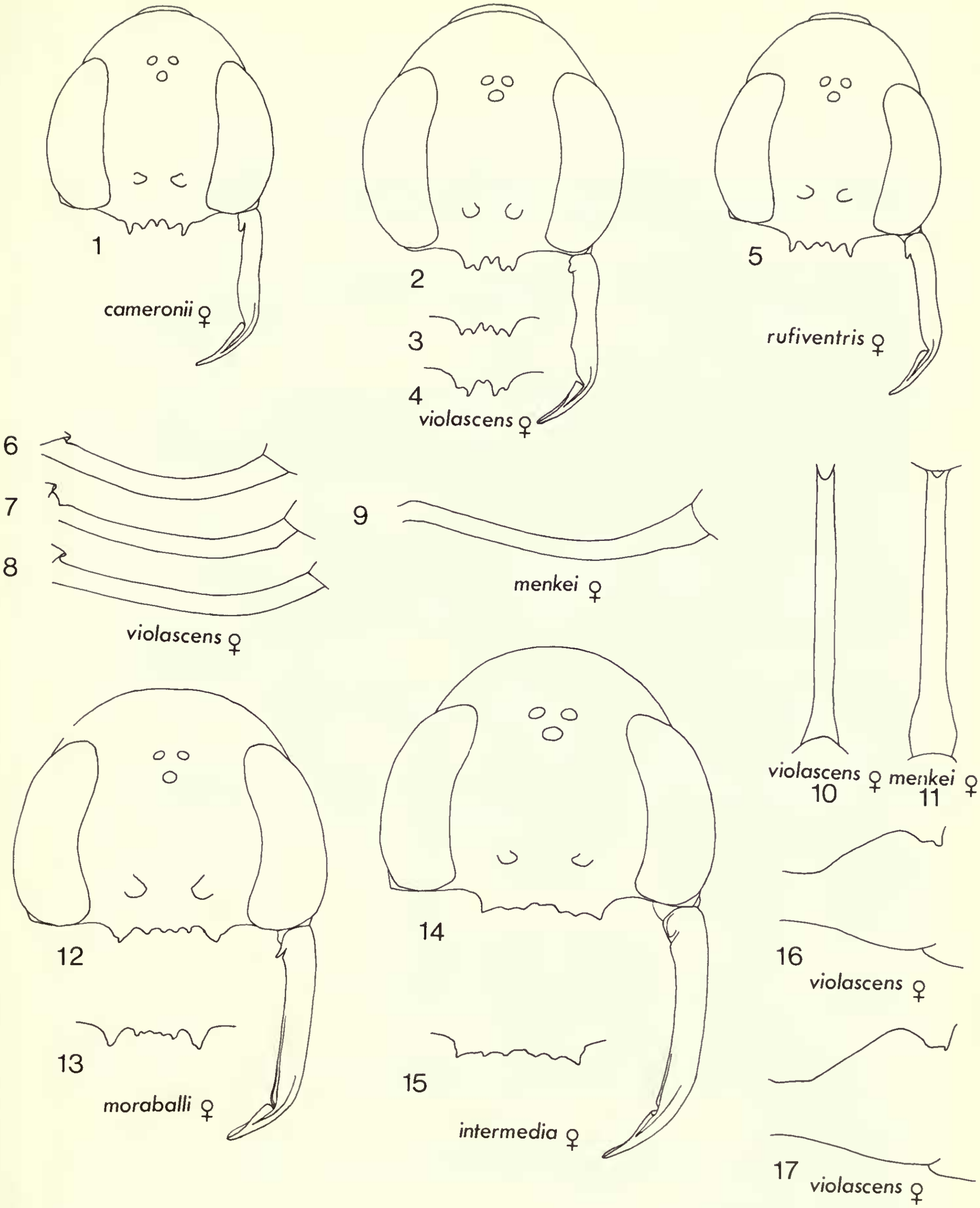
Key to species

It is important to open the mandibles, especially of females. Mandibular expansions are best observed dorsolaterally.

Females

The female of *grylloctonus* is unknown.

1	Body entirely dark, with violet-blue metallic lustre	2
–	Head and thorax black, gaster except petiole red (sometimes dark red)	3
2	Pronotal dorsum in profile shallowly, evenly convex. Petiole of even width (Fig. 1). (West of the Andes, north to Mexico) . . . . ***cameronii*** (Kohl) (p. 136)	
–	Pronotal dorsum in profile with weak, angular projection posteriorly (Figs 16, 17). Petiole slightly expanded posteriorly (Figs 2–4, 6–8, 10). (Widespread east of the Andes) ***violascens*** (Dalla Torre) (p. 131)	
3	Pronotal dorsum in profile shallowly, evenly convex	4
–	Pronotal dorsum in profile with sharply angulate projection posteriorly	6
4	Petiole with small but distinct expansion just before junction with tergite 1 (Figs 9, 11) ***menkei*** sp. n. (p. 133)	
–	Petiole of even width	5
5	Pronotal dorsum with shallow but distinct longitudinal groove . . ***howesi*** sp. n. (p. 138)	
–	Pronotal dorsum with at most an indistinct longitudinal groove ***rufiventris*** (Fabricius) (p. 133)	
6	Clypeus with 6 or more teeth, outermost pair strongly bent forward, those between often weak or irregularly spaced. Mandible stout, evenly tapered, with large notch (Figs 12–15, 22, 23)	7



Figs 1–17 *Trigonopsis* spp. (1–5) heads and clypeal variants. (6–11) petioles. (6–9) left side. (10, 11) dorsal view. (12–15) heads and clypeal variants. (16, 17) pronota, left side.

– Clypeus with 4 or 5 teeth, usually well formed and regularly spaced, outermost pair frequently weakly bent forward or straight. If mandible stout, inner side at least slightly expanded before notch, which is often small 9

7 HW at least 4·4. BL 22–27. Mandibular inner margin without basal spine. CTW at least 1·5 (Figs 14, 15) . . . . ***intermedia*** Saussure (p. 143)

– HW at most 4·5. BL 13–22. A small, basal spine or tooth present on mandibular inner margin. CTW at most 1·5 8

8 4 smaller teeth of clypeus fairly equal in size and spacing. HW 4·1–4·2. Mandibular notch not overhung by a carina, apical part of mandible much more slender than basal (Figs 12, 13) ***moraballi*** Richards (p. 145)

– 4 smaller teeth of clypeus often irregular, centre pair separated by a wide, shallow gap which is sometimes filled by a blunt, vestigial seventh tooth. HW 4·3–4·5. Mandibular notch partly overhung by a strong carina, apical part of mandible evenly tapered with basal (Figs 22, 23) ***cyclocephalus*** Smith (p. 144)

9 Outermost pair of clypeal teeth equal to or slightly shorter than adjacent pair. Mandible with notch small and step-like, before which the inner margin is moderately expanded (Figs 18–20, 24, 25) 10

– Outermost pair of clypeal teeth distinctly longer than adjacent pair. Mandible often not as above 11

10 BL 22–26. CR 1·8–2·2. PL 3·7–4·4. Propodeal dorsum with coarse rugae outside central groove, which is deep throughout. Small, basal spine on mandibular inner margin rather broad, rounded at tip. Top of pronotal projection very strongly raised, in profile with distinct concavity in front (Fig. 28). Wings strongly amber-tinted, stigma pale. Clypeus with 2 central gaps between teeth deeper than outer ones. HW 3·8–4·6 (Figs 24, 25) ***succinea*** sp. n. (p. 149)

– BL 19–20. CR 2·7–2·9. PL 2·9–3·2. Propodeal dorsum with fine rugae outside central groove, which is shallow anteriorly. Small basal spine on mandibular inner margin narrower, sharply pointed. Top of pronotal projection less strongly raised, scarcely concave in front (Fig. 27). Wings not amber-tinted, stigma dark brown, most veins dark. Clypeus with 2 central gaps equal to or shallower than outer ones. HW 3·7–3·9 (Figs 18–20) ***neotropica*** sp. n. (p. 147)

11 Antennal segment 3 longer than 4 and 5 together. Mandible slender, evenly tapered, rather strongly curved, with distinct, U- to V-shaped notch. MR 1·9–3·2. Clypeus with 2 large teeth and 3 smaller ones between (Figs 21, 26) 12

– Antennal segment 3 not longer than 4 and 5 together. Mandible variously shaped but not as above, notch sometimes small or vestigial. MR at least 2·4. Clypeus not always as above . 13

12 MR 2·7–3·2 (–5·6) MIW 2·2–2·4 times CTW. Antennal segment 3 is 2·5–2·8 times as long as 6. CR 1·3–1·6. Centre tooth of clypeus equal to or slightly longer than adjacent pair. BL 16–19. HW 3·1–3·7 (Fig. 21) . . . . ***vicina*** (Dalla Torre) (p. 141)

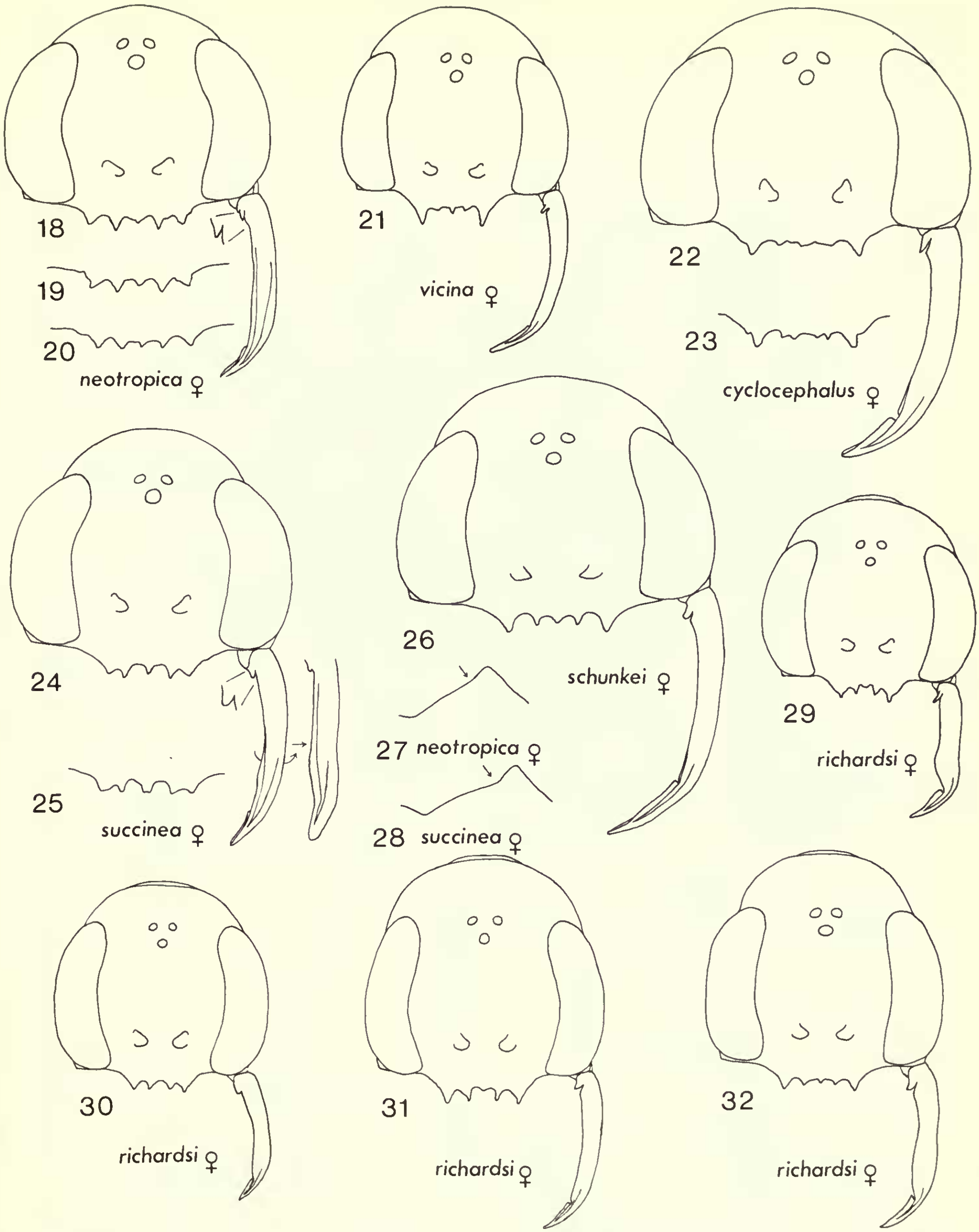
– MR 1·9–2·3. MIW 1·7–2·1 times CTW. Antennal segment 3 is 2·9–3·3 times as long as 6. CR 1·6–2·1. Centre tooth of clypeus equal to or shorter than adjacent pair. BL 18–22. HW 3·7–4·4 (Fig. 26) . . . . ***schunkei*** sp. n. (p. 142)

13 HW 2·8–3·5, at most 0·1 more than HL. Occipital carina ± expanded into a thin, lamellar flange, often translucent. BL 13–17. Mandibular inner margin ± strongly expanded before V-shaped notch. Mandible usually sharply bent at notch and abruptly tapered after it, upper edge of apex inflexed near notch (Figs 29–32) . . . . ***richardsi*** sp. n. (p. 140)

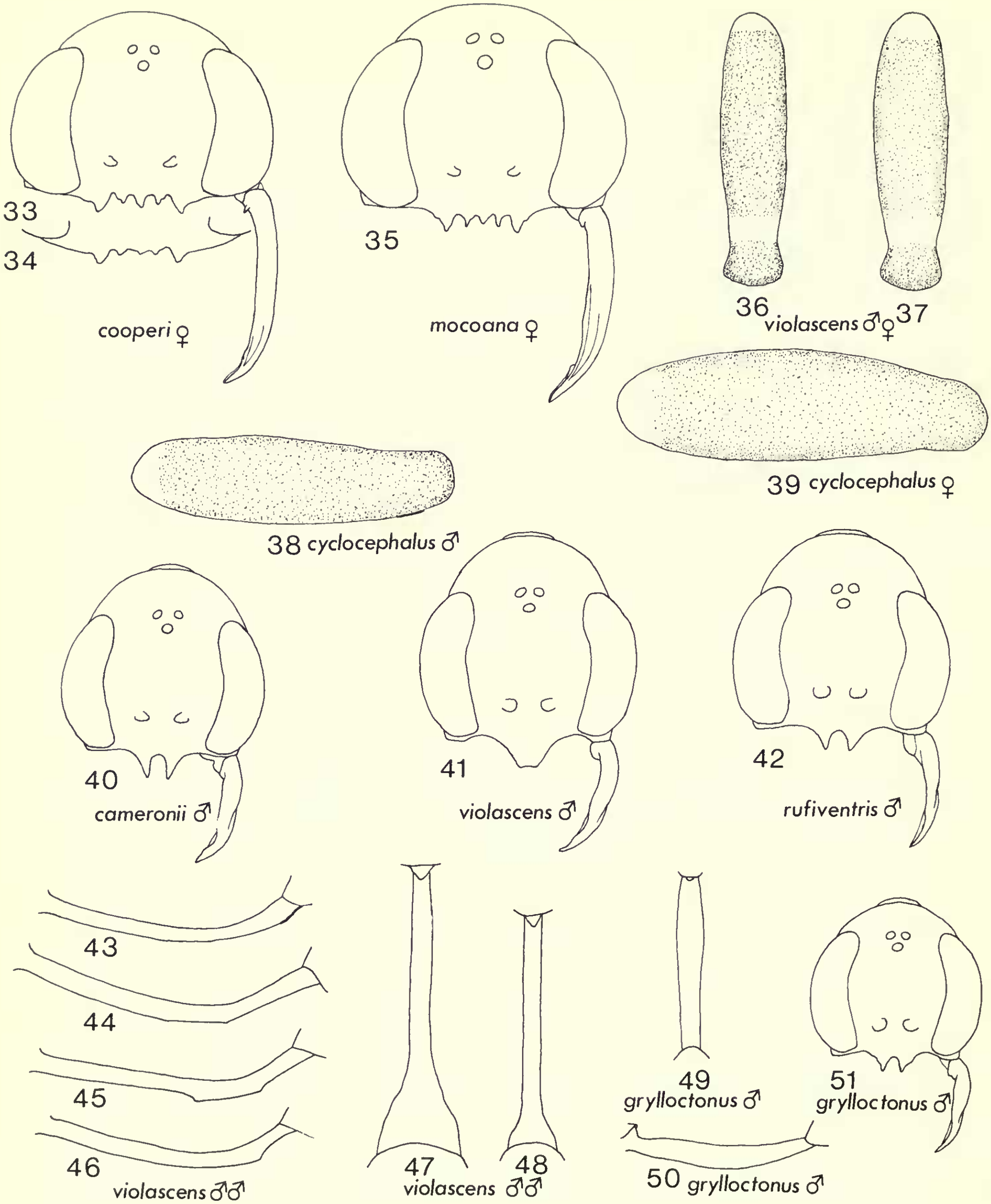
– HW 3·5–4·0, at least 0·66 more than HL. Occipital carina very strong but not forming a flange. BL 17–20. Mandibular inner margin at most moderately expanded before step-like notch. Mandible often shallowly bent at notch, rarely abruptly tapered after it. Upper edge of apex not inflexed 14

14 Mandible stout, inner margin moderately expanded before notch, which is small but distinct. MR 3·4–3·8. EL 2·2–2·3. Toothbearing area of clypeus more projecting, margin outside teeth at steep angle, so that CR is 1·3–1·7; all clypeal teeth bent forward, outermost pair most strongly (Fig. 35) . . . . ***mocoana*** sp. n. (p. 149)

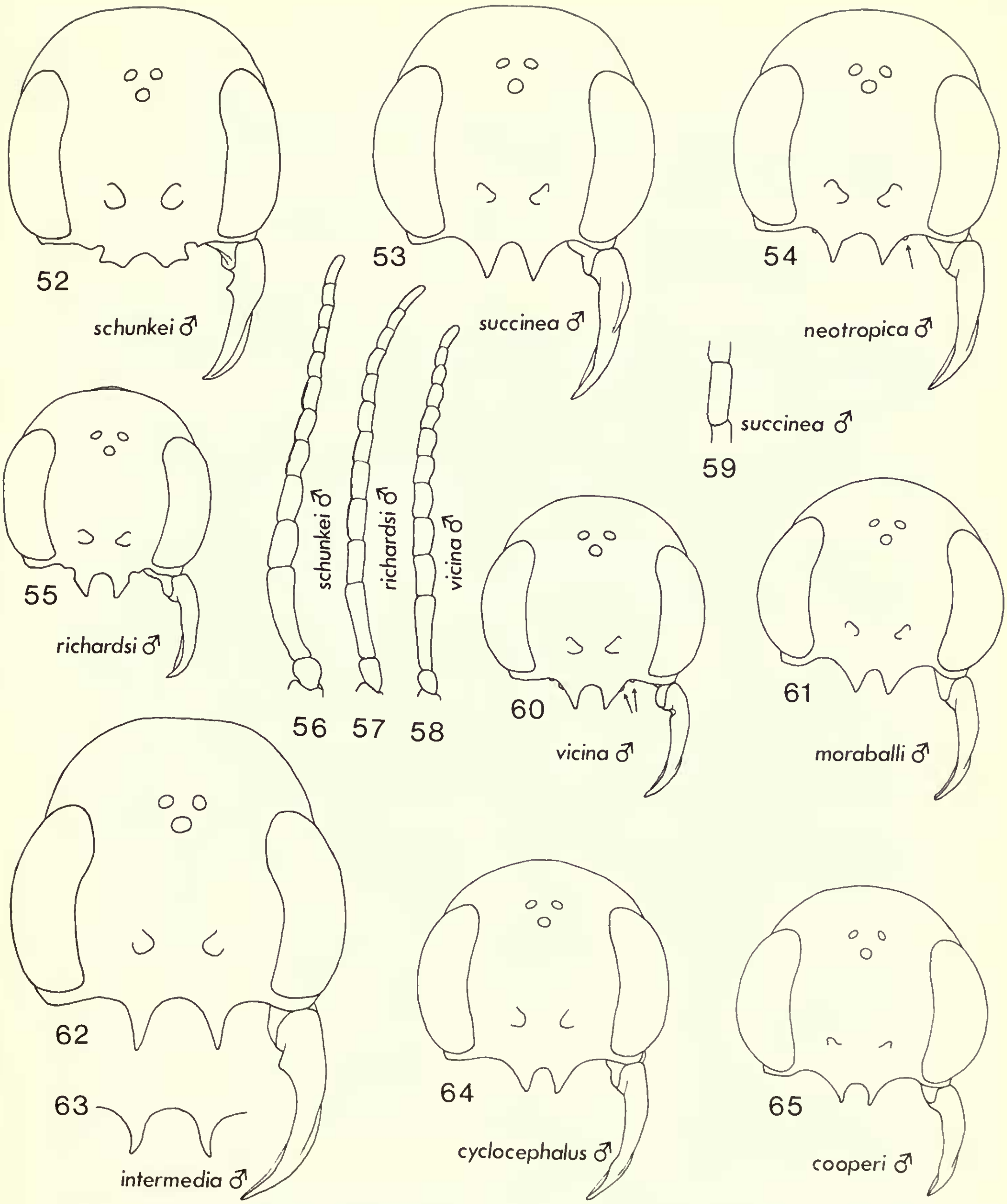
– Mandible slender, evenly tapered, notch vestigial. MR 3·6–5·5 (–7·3). EL 2·0–2·3. Tooth-bearing area of clypeus less projecting, margin outside teeth at shallower angle (where almost sympatric with *mocoana*, forming a broad, translucent lamella), so that CR is 1·8–2·7; only outermost pair of teeth bent forward, contrasting with others (Figs 33, 34) ***cooperi*** sp. n. (p. 150)



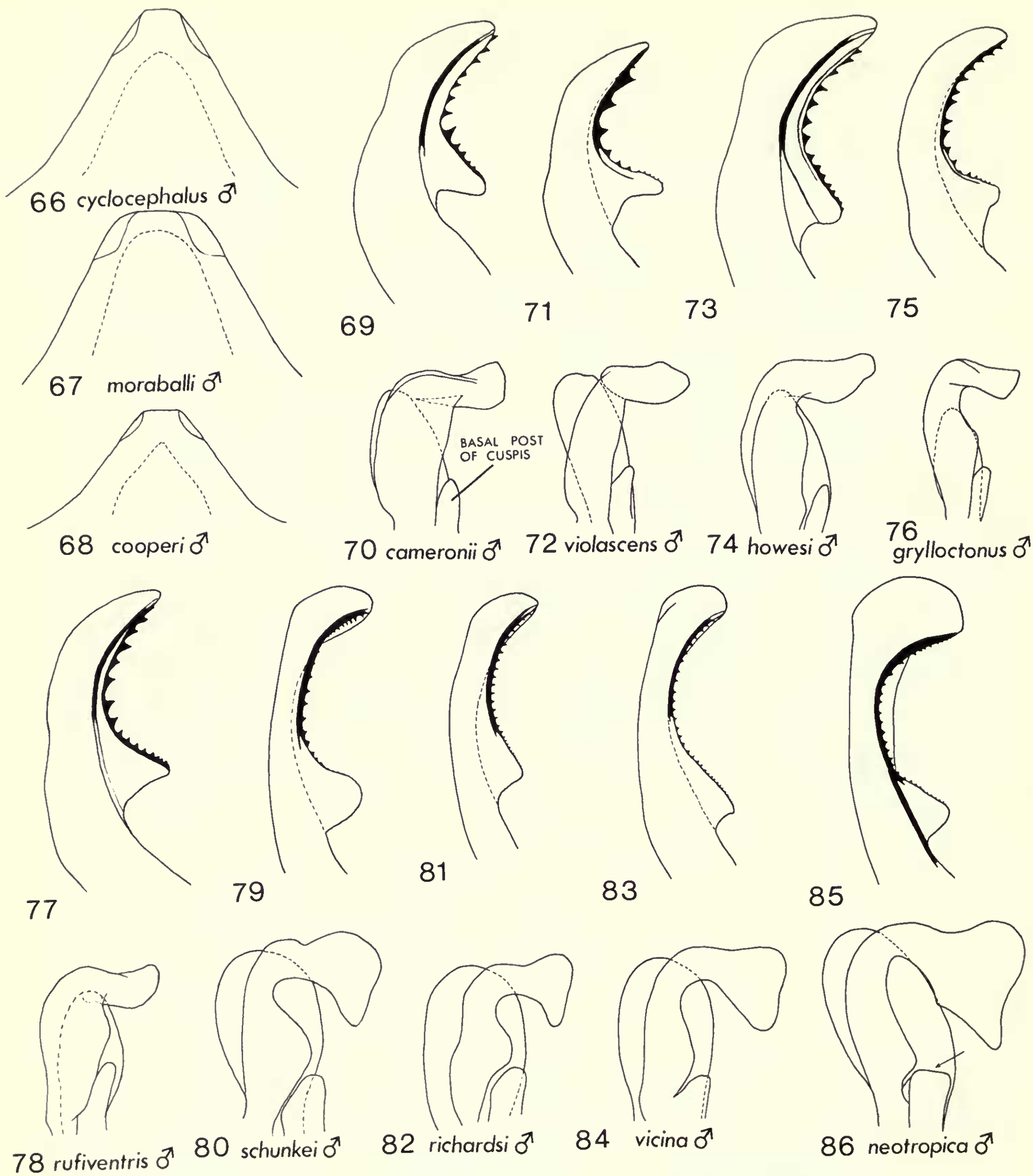
Figs 18–32 *Trigonopsis* spp. (18–26) heads and clypeal variants. (27, 28) pronotal dorsa, left side. (29–32) heads.



Figs 33–51 *Trigonopsis* spp. (33–35) heads and clypeal variants. (36–39) cocoons. (40–42) heads. (43–50) petioles showing (43–46) left side; (47–49) dorsal view; (50) left side. (51) head.



Figs 52–65 *Trigonopsis* spp. (52–55) heads. (56–59) antennae. (60–65) heads and clypeal variants.



Figs 66–86 *Trigonopsis* spp. (66–68) sternites 8. (69–86) aedeagi and volsellae.

Males

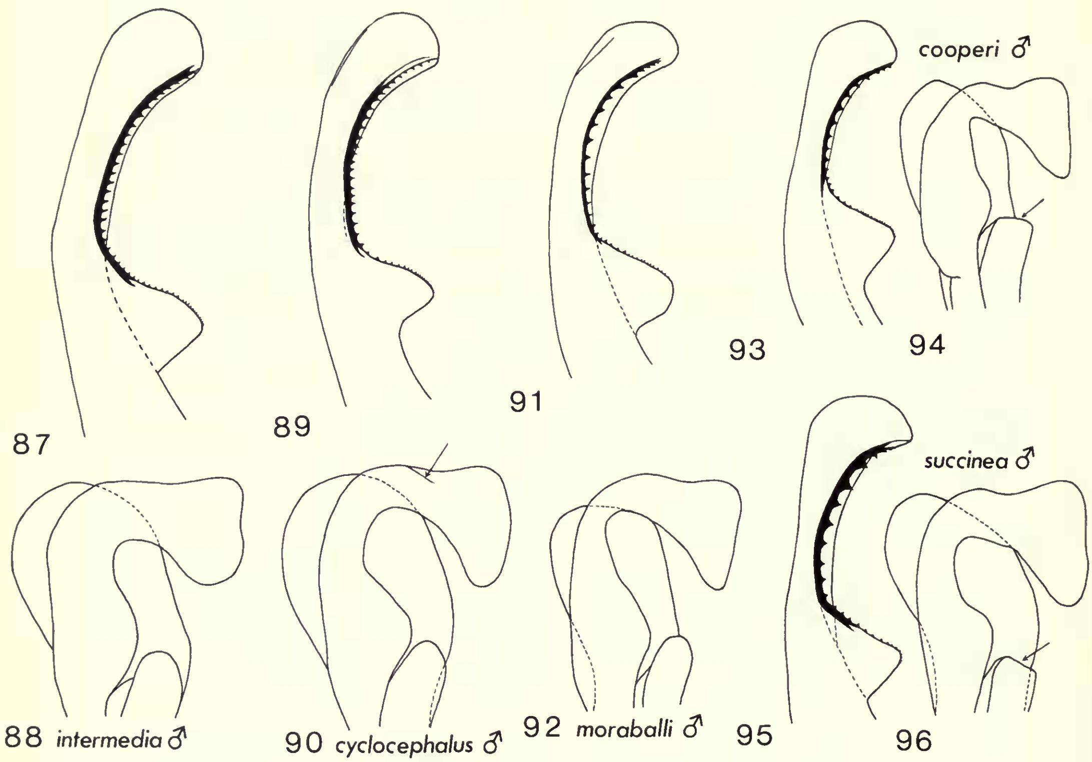
The males of *menkei* and *mocoana* are unknown.

1 Body entirely dark, with violet-blue reflections 2
– Head and thorax black, gaster except petiole red (sometimes dark red) 3
2 Clypeus with 2 large, sharp teeth (Fig. 40). Pronotal dorsum in profile shallowly, evenly convex. Petiole in dorsal view of uniform width throughout. Genitalia as in Figs 69, 70. (West of the Andes, north to Mexico) . . . . . ***cameronii*** (Kohl) (p. 136)
– Clypeus with large, central truncate projection (Fig. 41). Pronotal dorsum in profile, with weakly angular posterior projection (cf. Figs 16, 17). Petiole in dorsal view, strongly expanded at junction with tergite 1 (Figs 43–48). Genitalia as in Figs 71, 72. (Widespread east of the Andes) . . . . ***violascens*** (Dalla Torre) (p. 131)
3 Pronotal dorsum in profile, shallowly, evenly convex 4
– Pronotal dorsum in profile, with sharply angulate projection posteriorly 6
4 Petiole strongly expanded in middle (Figs 49–51). Genitalia as in Figs 75, 76 ***grylloctonus*** Richards (p. 139)
– Petiole of even width throughout 5
5 Pronotal dorsum with shallow longitudinal groove. Genitalia as in Figs 73, 74 ***howesi*** sp. n. (p. 138)
– Pronotal dorsum without any trace of a longitudinal groove (Fig. 42). Genitalia as in Figs 77, 78 . . . . ***rufiventris*** (Fabricius) (p. 133)
6 Clypeus with 2 large, rectangular, divergent lobes. Mandibular inner margin with sub-basal tooth (Fig. 52). Antennae as in Fig. 56. Genitalia as in Figs 79–80 . . . . ***schunkei*** sp. n. (p. 143)
– Clypeus with 2 large, sharp teeth, its tooth-to-orbit margin with at most a notch. Mandibular inner margin sometimes with sub-basal tooth 7
7 Antennal segments moderately to strongly dorsoventrally flattened, their junctions offset in lateral view (Fig. 59). Mandibular inner margin without sub-basal tooth . . . 8
– Antennal segments almost perfectly cylindrical, their junctions not or scarcely offset in lateral view. Mandibular inner margin sometimes with sub-basal tooth 11
8 Clypeal tooth-to-orbit margin entire and without any tubercles behind (view from below) (Fig. 53). BL 17–20, HW 3·3–3·8, HL 3·0–3·5, PL 2·7–3·8. Genitalia as in Figs 95, 96 . . . . ***succinea*** sp. n. (p. 149)
– Clypeal tooth-to-orbit margin with at least 2 tubercles behind (view from below), sometimes also with a deep notch visible in front view. BL 13–18, HW 2·7–3·6, HL 2·7–3·3, PL 2·3–2·9 9
9 Clypeal tooth-to-orbit margin in front view, with a deep U-shaped notch. Seen from below, sides of notch are tuberculate behind, and outer tubercle is connected to a third one still further back (Fig. 55). Antennal segments 5 and 6 slightly expanded (Fig. 57). Genitalia as in Figs 81, 82 . . . . ***richardsi*** sp. n. (p. 140)
– Clypeal tooth-to-orbit margin almost entire in front view but seen from below, base of outer side of each tooth is tuberculate behind. Beyond it, and behind tooth-to-orbit margin but not forming part of it, is another tubercle. The two tubercles together form a deep notch, and tip of second is just visible in front view. Antenna not as above (Figs 54, 60) . . 10
10 Antennal segments 5–10 strongly expanded (Fig. 58). Eyes strongly divergent downwards (Fig. 60). Genitalia as in Figs 83, 84 . . . . . . ***vicina*** (Dalla Torre) (p. 141)
– No antennal segments expanded, only flattened. Eyes scarcely divergent downwards (Fig. 54). Genitalia as in Figs 85, 86 . . . . ***neotropica*** sp. n. (p. 147)
11 Mandibular inner margin with sub-basal tooth. BL 19·5–23·0, HW 3·9–4·5, CTW 0·90–1·05, CDR 1·4–1·7, CR 0·9–1·1 (Figs 62, 63) Genitalia as in Figs 87, 88 . . . . ***intermedia*** Saussure (p. 143)
– Mandibular inner margin without sub-basal tooth. BL 15·0–19·0, HW 3·1–3·7, CTW 0·30–0·40, CDR 0·9–1·1, CR 0·40 12
12 TOD 0·85–0·97, PDL 1·8–2·2, third antennal segment 1·1–1·3 long and 1·8–1·9 times as long as the first, eyes slightly divergent below, CED 0·35–0·40, HL 2·8–3·2, HW 3·1–3·7, CTW 0·35–0·40, PL 2·3–3·0 (Fig. 63) (Upper Amazon). Sternite 8 as in Fig. 66. Genitalia as in Figs 89, 90 . . ***cyclocephalus*** Smith (p. 145)
– TOD 0·70–0·77, PDL 1·7–1·9, antennal segment 3 is 0·9–1·0 long and 1·5–1·6 times as long as the first, eyes parallel or slightly convergent below, CED 0·27–0·32, HL 2·8–2·9, HW 3·1–3·3, CTW 0·30–0·35, PL 2·4–2·6. (Amazon and Guyana) 13
13 MIW 0·35 more than UIW, PDL 1·7–1·8, PL 2·4–2·5, CTW 0·35, CED 0·32 (Fig. 61). Sternite

8 rather sharply keeled, its tip broadly rounded (Fig. 67). Genitalia as in Figs 91, 92 (Guyana) . . . . ***moraballi*** Richards (p. 146)

MIW 0·15–0·20 more than UIW, PDL 1·8–1·9, PL 2·6, CTW 0·30–0·32, CED 0·27–0·30 (Fig. 65). Sternite 8 obtusely keeled, its tip narrowly truncate (Fig. 68). Genitalia as in Figs 93, 94. (Amazon mainstream from Tena to Piauí, and East Peru) . ***cooperi*** sp. n. (p. 150)

N.B. The last three males are extremely similar externally, although *cooperi* is easily distinguished by its genitalia. The differences between the genitalia of *cyclocephalus* and *moraballi*, although slight, appear to be constant.



Figs 87–96 *Trigonopsis* spp., aedeagi and volsellae.

The *rufiventris*-group

Unique characters are: complete or almost complete lack of transverse rugae outside the central furrow of the propodeal dorsum in both sexes, and bifid sternite 8 and distinctive genitalia of the males. Further characters are: small, slender species with HR of 1·0 or less, very broad occipital flange. Female mandible sharply bent, inner margin with V-shaped notch and strong expansion before it, 5 usually sharp clypeal teeth, sternite 6 sharply keeled. Cuspis of male genitalia with round-ended basal post. Dark parts, at least of legs, ± metallic in all species.

Within the group, *violascens* is distinguished by the dorsal pronotal projection, lacking in the other species. Its male is further distinguished by the unique shape of its clypeus and petiole, and has the most distinct genitalic structure in the group. The female mandibular expansion, rounded in the other species, is angulate and the clypeal variation considerably greater.

This group is by far the most common and widespread of all. It contains the only species found west of the Andes. It includes all the known metallic species, and it is interesting that both of the entirely metallic-coloured species have a greater altitude range than any others of the genus. The group also includes the only species which lack a pronotal projection, and the single species known to have diverged in its prey choice. Furthermore, it appears that the group may recently have evolved rapidly, since with the exception of *violascens*, the species are very closely related (for example, the head ratios of the species of this group are much more uniform than those of the species of other groups). They are usually separated by small and often single structural characters, although sometimes also by considerable biological ones.

The species *rufiventris*, *cameronii* and *violascens* are apparently more common than any other *Trigonopsis*. Various factors may contribute to their frequency, such as: the unusual shape of the female mandibles and clypeus affording better grip of the prey; small average size reducing the need to find large or numerous prey; greater adaptability in choice of nesting site. Certainly *richardsi*, much the commonest species of the *vicina*-group, is very similar in at least the first two respects (its biology is unknown). The remaining species of the *rufiventris*-group, all of them apparently much less widely distributed, may represent specialized adaptations to certain very localized ecological niches.

Trigonopsis violascens (Dalla Torre)

(Figs 2–4, 6–8, 10, 16, 17, 36, 37, 41, 43–48, 71, 72, 99)

Trigonopsis violaceus Smith, 1851 : 31. Holotype ♂, Brazil (BMNH) [examined]. [Junior secondary homonym in *Sceliphron* Klug, of *Sphex violacea* F., 1775.]

Sceliphron violascens Dalla Torre, 1897 : 392. [Replacement name for *Trigonopsis violaceus* Smith.]

[*Podium* (*Trigonopsis*) *cameronii* Kohl, 1902 : 39, ♀ (part). Misidentification.]

Podium (*Trigonopsis*) *violaceum* Smith; Kohl, 1902 : 39, pl. 1, fig. 3, pl. 5, figs 55, 63 [not pl. 6, fig. 63 as stated in text], pl. 6, figs 70, 80, ♂.

Podium (*Trigonopsis*) *resplendens* Kohl, 1902 : 41, pl. 1, fig. 1, pl. 5, fig. 61, pl. 6, figs 72, 74 [actually an illustration of *violaceum*], pl. 7, fig. 85. Holotype ♀, Brazil (NM, Vienna) [examined]. [Synonymy by Richards, 1937 : 109.]

Trigonopsis violaceus Smith; Richards, 1937 : 109, 112.

Trigonopsis resplendens Kohl; Menke *in* Bohart & Menke, 1976 : 98.

Trigonopsis violascens (Dalla Torre); Menke *in* Bohart & Menke, 1976 : 98.

♀. BL 15·0–19·5 (but see below). Almost entirely dark, with blue-violet reflections, especially on head and gaster. Mandibular base stout, with angulate expansion on inner margin before the notch (Fig. 2). Even in tiny specimens, this angle is still represented by a point. Notch V-shaped, deep and narrow, proximally obtuse-angled, distally right-angled. Apex more slender than base, with upper edge strongly inflexed, especially near the notch. Pronotum with weakly angulate dorsal projection, of a shape different from that found in other species-groups (Figs 16, 17). Petiole slightly expanded at junction with gaster (Fig. 10). HW 2·8–3·4, HL 2·9–3·4, HR 0·9–1·0, EL 1·9–2·3, UIW 1·4–1·7, MIW 1·5–1·9, LIW 1·2–1·5, CTW 0·6–0·8, TOD 0·4–0·6, CR 1·1–1·6, MBL 1·3–1·9, MAL 0·4–0·8, MR 1·8–3·0, PDL 1·8–2·3, PL 2·6–3·3, PR 1·1–1·5. An exceptionally small specimen from the Mato Grosso differs as follows: BL 10·5, HW 2·0, HL 1·9, EL 1·4, UIW 1·0, MIW 1·1, LIW 0·8, CTW 0·4, TOD 0·3, MBL 1·0, MR 3·5, PDL 1·0, PL 1·6.

♂. BL 15·0–22·0. Inner margin of mandible always with middle and pre-apical expansions, the latter stronger (Fig. 41). Clypeus with a large, narrowly truncate projection (Fig. 41). (Because of its unusual shape it was not measured.) Pronotum with a very weakly angular projection (cf. Fig. 16). Petiole strongly expanded at junction with gaster (Figs 47, 48). Genitalia Figs 71, 72. HW 2·6–3·8, EL 1·6–2·2, UIW 1·3–2·1, MIW 1·4–2·3, LIW 1·2–2·1, PDL 1·6–2·6, PL 2·8–3·7, PR 1·4–1·8. Otherwise as ♀.

This species is like *cameronii* in colour, but is nowhere sympatric with it.

Variation. The truncated end of the male clypeal projection is often ± emarginate. In the female clypeus, the centre tooth varies from well-developed (about half the length of the outermost) to vestigial. The adjacent teeth vary considerably in length, from intermediate between the centre and outermost, to much longer than the outermost. As the latter extreme is approached, the outer pair of gaps becomes much shallower so that the clypeus takes the form of two bifid projections with a small tooth between, and also the mandibular expansion becomes more sharply angulate

(Figs 2–4). The projection on the pronotal dorsum, more broadly based than that found in other species-groups, is normally low. On average, it is stronger in the Guianas (Fig. 16) and still more so towards the Andean foothills (Fig. 17). The depth of the cleft in the apex of the projection also varies, but in a less clear pattern. The normally medium-sized punctures of the mesoscutum are occasionally very fine. The gastral petiole, normally rather strongly upcurved distally, is sometimes extremely strongly curved, when it also appears thicker than usual. Ventrally, it has 0–2 rather strong angles in males (Figs 43–46) and sometimes a single weak one in females (Figs 6–8). In a male from Leticia the apex of sternite 8 has a single, central spine instead of being bifid. In all this variation it has not so far been possible to find any consistently coinciding aspects which could indicate the existence of more than a single species.

Distribution. Very widespread east of the Andes, ascending to about 850 m, higher than any other species in that area (map, Fig. 99). This and *neotropica* are the only species so far recorded from the Mato Grosso (see also discussion under *cameronii* distribution).

Biology. Cooper found the following nests. Colombia: Putumayo, Alto Afan near Mocoa, 19.vi.1974: nest with smooth surface, on rock face. Wasp sitting on nest with four empty cells. Indistinguishable from *rufiventris* nest nearby. Amazonas, Leticia, 20.viii.1974: three large nests attached to rootlets of fallen tree. Two nests (preserved in BMNH) measure about 65 mm high, 42 mm along the cells and 30 mm across them with about 9 cells, and 60 × 27 × 30 mm with about three cells. The overall shape is rather like that of a hanging pear, with an upper mass of mud acting as a holdfast, and the cells fixed horizontally below it. The extra mud covering the cells is rough, solid and irregular, overlaid by very many loose pellets. Cockroach prey taken from one of these nests consisted of Blattellidae: 2 nymphs of 1 sp., gen. indet. (det. Gurney). Mocoa, 23.iii.1974, suspended from a rootlet under a bank. It had about five cells and (possibly due to age) a smooth surface. The considerable difference in the form of the final nest-covering used between the two kinds of nesting-site (rock-face and rootlet) would be consistent with its serving the purpose of camouflage.

The cocoons were narrow, black, with two bands of white fibrous material (Figs 36, 37).

Richards (1937 : 109) refers to a Dipterous parasite *Amobia* (as *Pachyophthalmus*) *floridensis antillarum* Richards, bred from a nest of this species in Trinidad.

Material examined. Dates and collectors' names omitted.

Trigonopsis violaceus Smith, holotype ♂, Brazil: Pará, Belém (*Wallace & Bates*) (BMNH). *Podium* (*Trigonopsis*) *resplendens* Kohl, holotype ♀, Brazil: no further data (NM, Vienna).

French Guiana: 1 ♂, Tollinche, River Maroni; 1 ♀, no further data (MNHN, Paris); 1 ♀, no further data (NM, Vienna) (paralectotype of *cameronii*); 1 ♀, no further data (MHN, Geneva). Surinam: 2 ♀, 1 ♂, Malaise trap (RNH, Leiden). Guyana: 1 ♀, Bartica (ANS, Philadelphia); 1 ♀, Essequibo River, Moraballi Creek (*c.* 30 km SE. Bartica) (BMNH). Trinidad: 1 ♀, St Augustine (USNM, Washington); 1 ♀, 9 km N. Arima, 440 m; 3 ♀, no further data (BMNH). Colombia: 1 ♀, 1 ♂, Amazonas, Leticia; 1 ♀, Amazonas, R. Igara Paraná, La Chorrera (mislabelled 'Peru, Putumayo District') (CU, Ithaca); 2 ♀, 1 ♂, Putumayo, Mocoa; 2 ♀, Putumayo, Alto Afan, 7 km NE. Mocoa; 3 ♀, 3 ♂, Meta, Cord. Macarena (BMNH); 1 ♀, further data illegible (UM, Oxford). Peru: 2 ♀, Huánuco, Tingo Maria (BMNH); 1 ♀, same locality (Menke coll.); 1 ♀, same locality (Fritz coll.); 1 ♀, same locality, 620 m (MCZ, Harvard); 1 ♀, Huánuco, Tingo Maria (Rio Huallaga), 700 m (IML, Tucumán); 1 ♀, Huánuco, Cord. Azul, Previsto, 850 m (BMNH); 1 ♀, Huánuco, Pachitea (TM, Budapest); 1 ♂, Huánuco, Monzon (Menke coll.); 1 ♀, Cuzco, Rio Cosñipata Valley, Hacienda Maria, 400 m (IML, Tucumán); 1 ♀, Junín, Chanchamayo (USNM, Washington); 1 ♀, 1 ♂, same data (Menke coll.); 1 ♀, Amazonas, Rio Santiago (AMNH, New York). Bolivia: 1 ♀, La Paz, Coroico (*c.* 500 m) (MNHU, Berlin). Brazil: 2 ♀, Mato Grosso, 12.50 S., 51.47 W., one reared iii.1968 from mud cells, side of shallow pit; the other on mud pit, cerradão, 11.ii.1968 (BMNH); 1 ♀, Pará, Belém (RNH, Leiden); 1 ♀, Pará, R. Arrayolos (MP, Belém); 1 ♀, Amazonas, R. Japurá (MP, Belém); 1 ♂, no further data (UM, Oxford); 2 ♂, no data (USNM, Washington); 1 ♂, no data (NM, Vienna).

Trigonopsis menkei sp. n.

(Figs 9, 11, 99)

♀. BL 22–24. Pronotum without dorsal projection. Gaster red. Petiole with small but distinct lateral expansion just before junction with gaster (Figs 9, 11). HW 3·8–4·1, HL 3·9–4·2, HR 0·9–1·0, EL 2·6–2·7, UIW 1·7–1·8, MIW 2·0–2·2, LIW 1·7–1·9, CTW 0·8–1·0, TOD 0·7–0·85, CR 1·1–1·2, MBL 2·0–2·1, MAL 0·8–1·4, MR 1·5–2·3, PDL 2·7–2·9, PL 3·7–3·9, PR 1·3–1·4. Otherwise as *rufiventris*.

♂. Unknown.

This species differs from its close relatives only in petiole shape.

VARIATION. Mainly in clypeus, as in *rufiventris*.

DISTRIBUTION. Iquitos and near Tena only (map, Fig. 99).

BIOLOGY. Unknown.

MATERIAL EXAMINED. Holotype ♀, ECUADOR: Napo, Río Jatún Yacu (1.04 S., 77.48 W.), 700 m (*MacIntyre*) (MCZ, Harvard).

Paratypes. ECUADOR: 1 ♀, same data as holotype (BMNH). PERU: 1 ♀, Loreto, Iquitos (*Bassler*) (AMNH, New York); 1 ♀, Loreto, Iquitos, 4.viii.1906 (*Ducke*) (MP, Belém).

Trigonopsis rufiventris (Fabricius)

(Figs 5, 42, 77, 78, 97)

Podium rufiventre Fabricius, 1804 : 184. Holotype ♀, SOUTH AMERICA (UZM, Copenhagen) [examined].
Trigonopsis abdominalis Perty, 1833 : 142, pl. 27, fig. 18. Holotype ♀, SOUTH AMERICA (ZSBS, Munich) [examined]. [Synonymy by Smith, 1856 : 226.]
Trigonopsis haemorrhoidalis Smith, 1856 : 226, 479. [Unavailable name, inadvertently published in the synonymy of *Podium rufiventre* F.]
Trigonopsis soror Mocsary, 1883 : 23. Holotype ♀, BRAZIL (TM, Budapest) [examined]. [Synonymy by Kohl, 1902 : 37.]
Trigonopsis frivaldskyi Mocsary, 1883 : 23. Holotype ♀, BRAZIL (TM, Budapest) [examined]. [Synonymy by Kohl, 1902 : 37.]
Trigonopsis rufiventris (Fabricius); Menke *in* Bohart & Menke, 1976 : 98.
Trigonopsis soror Mocsary; Menke *in* Bohart & Menke, 1976 : 98.

♀. BL 15–23. Occipital carina flange-like. Pronotal dorsum without projection and with at most an indistinct longitudinal groove. Gaster red. Petiole of even width. HW 2·7–3·9, HL 2·7–4·2, HR 0·9–1·0, EL 1·9–2·6, UIW 1·3–1·7, MIW 1·5–2·0, LIW 1·2–1·7, CTW 0·65–0·85, TOD 0·50–0·75, CR 1·1–1·6, MBL 1·35–1·90, MAL 0·7–1·3, MR 1·5–1·9 (–2·1), PDL 1·8–2·9, PL 2·5–4·0, PR 1·3–1·6. (Fig. 5.)

♂. BL 13·5–19·0. Clypeus with two large, sharp teeth. Pronotum with at most the slightest trace of a longitudinal groove. Genitalia as in Figs 77, 78. HW 2·6–3·3, HL 2·6–3·5, HR 0·9–1·0, EL 1·8–2·3, UIW 1·3–1·7, MIW 1·4–1·8, LIW 1·2–1·6, CTW 0·25–0·32, CED 0·22–0·35, CER 0·9–1·3, TOD 0·57–0·75, CR 0·4–0·5, PDL 1·6–2·4, PL 2·7–3·7, PR 1·3–1·7. (Fig. 42.) Otherwise as ♀.

This species differs from *cameronii* in colour and distribution, and from other close relatives in its unmodified pronotum and petiole.

VARIATION. The females show much variation. The five clypeal teeth and the gaps between them may be subequal; sometimes the outer two pairs of teeth are longer and the centre one reduced (Fig. 5). The tooth-to-orbit margin is normally straight, but occasionally may be strongly convex near the tooth. The propodeal dorsal and posterior faces normally form an obtuse angle at their junction, but occasionally merge in a shallow curve. The propodeal dorsum of large specimens occasionally bears traces of transverse rugae also outside the central furrow. Only three males of the seventeen examined had the inner mandibular margin with a preapical expansion, and none had a middle expansion (Fig. 42). (Cf. *violascens* Fig. 41.)

(For details of colour variation see general discussion p. 121.)

DISTRIBUTION. Widespread east of the Andes, from Colombia to the Guianas in the north, and south to Peru in the west and Rio de Janeiro in the east (map, Fig. 97).

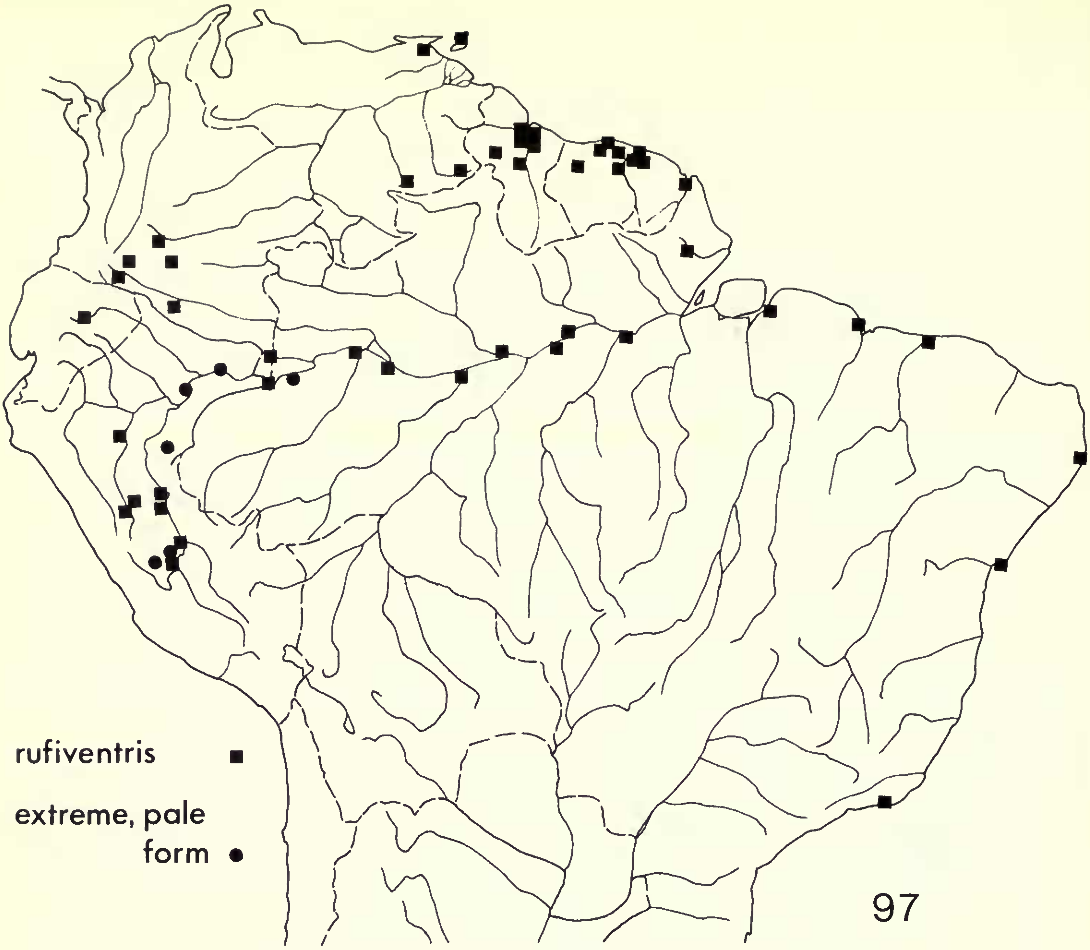


Fig. 97 Collection localities of *T. rufiventris*.

BIOLOGY. Arlé (1933) described nests of 2–12 cells built on rock-faces, just south of Rio de Janeiro. The cells were invariably horizontal, with a rough mud covering. Cockroach nymphs were used as prey. *Photocryptus apicalis* Schmiedeknecht (Ichneumonidae) was a parasite.

Williams (1928 : 115) found two nests near Tena, Ecuador, each fastened to the underside of a palm leaf near the ground. The prey were cockroaches.

Richards (1937 : 109) found two incomplete nests in Guyana, Essequibo River, Moraballi Creek (*c.* 30 km SE. Bartica). One was on a tree branch and had six cells (possibly built by two females), the other was under the roots of a fallen tree and had four cells. Both nests were about 1·3 m from the ground and had the cells 'mouths upwards'. (This is the only record of vertical orientation.) The cell building method was identical to that described by Eberhard (1974) for *cameronii.* Cockroaches, of which at least one was adult, were used as prey.

Cooper found nests in Colombia: Mocoa attached to a vertical tree trunk; to the underside of a fallen tree; and to the underside of a palm leaf. The last nest had only just been begun, but the other two were rather large, with a smooth surface.

Cocoons were similar to those of *violascens* (cf. Figs 36–37).

A female wasp, taken at Mocoa on 1.vi.1976 by Cooper, was walking over and around several old and new nests built on the sides and underside of a boulder on the ground. In one cell in each of two nests was a mixture of cockroach and cricket prey. These were named by Gurney as follows. First cell: Gryllidae, 2 ♂, 2 ♀ *Anaxipha* sp. nr *peruviana* (Saussure); Blattellidae, 3 nymphs, all of different species, 1 *Chorisoneura* sp., 2 gen. indet. Also 1 adult ♀ *Anaplecta* sp. Second cell: Gryllidae, 1 nymph Eneopterinae, gen. indet.; Blattellidae, 1 ♂ *Calhypnorna* sp. Only *T. grylloctonus* has hitherto been reported as preying on crickets. However, it is not certain that the present wasp was involved with any of the cells near which it was found. Further observation is needed to establish whether *T. rufiventris* also sometimes takes crickets.

MATERIAL EXAMINED. Dates and collectors' names omitted.

Podium rufiventris Fabricius, holotype ♀, GUYANA: Essequibo (*Smidt*) (UZM, Copenhagen). *Trigonopsis abdominalis* Perty, holotype ♀, BRAZIL (ZSBS, Munich). *Trigonopsis soror* Mocsary, holotype ♀, BRAZIL: Amazonas, São Paulo de Olivença (TM, Budapest). *Trigonopsis frivaldskyi* Mocsary, holotype ♀, BRAZIL: 'Massanary' ['Sao Paulo' on label], (TM, Budapest).

PERU: 1 ♀, Junín, Chanchamayo Valley, 800 m (IML, Tucumán); 1 ♀, Junín, Satipo, 750 m (NM, Rotterdam); 2 ♀, Loreto, Col. Perené, El Campamento (CU, Ithaca); 1 ♀, Huánuco, Cayumba, 35 km S. Tingo Maria, 800 m (BMNH); 1 ♀, Loreto, River Pachitea (TM, Budapest); 1 ♀, Loreto, Atalaya, Upper River Ucayali (BMNH); 10 ♀, 2 ♂, Loreto, Pucallpa (BMNH); 1 ♀, Loreto, Pucallpa, 180 m (Menke coll.); 1 ♀, Loreto, Pucallpa, 200 m (CMNH, Los Angeles); 1 ♀, Loreto, Boquerón Abad (BMNH); 1 ♀, Loreto, Chambireyacu, near Yurimaguas, River Huallaga (MNHN, Paris); 2 ♀, Loreto, Rio Tapiche (AMNH, New York); 1 ♂, Loreto, Iquitos (MP, Belém); 2 ♀, Loreto, Iquitos, San Roque (CU, Ithaca); 4 ♀, Loreto, Pebas (3 TM, Budapest; 1 Menke coll.); 1 ♀, no further data (MNHU, Berlin). ECUADOR: 1 ♂, Napo, Tena (BPBM, Honolulu); 1 ♀, Napo, Tena (MNHN, Paris). COLOMBIA: 11 ♀ (incl. 1 reared), 3 ♂ (incl. 1 reared), Putumayo, Mocoa (BMNH); 4 ♀, 2 ♂, Putumayo, Alto Afan near Mocoa (BMNH); 1 ♀, Caqueta, Florencia, 480 m; 4 ♀, 1 ♂, Meta, Cord. Macarena; 1 ♀, Amazonas, Leticia; 1 ♀, Amazonas, Tarapaca; 3 ♀, Amazonas, La Chorrera (BMNH); 1 ♀, 'Bogota'* (MNHN, Paris). VENEZUELA: 1 ♀, Bolívar, Surukum (CU, Ithaca); 1 ♀, Bolívar, Canaracuni, 450 m (IZA, Maracay); 1 ♀, 1 ♂, Monagas, Caripito (MCZ, Harvard). GUYANA: 7 ♀, 1 bred ♂, Essequibo River, Moraballi Creek (*c.* 30 km SE. Bartica); 2 ♀, Mazaruni (*c.* 10 km NW. Bartica), 2nd growth (low forest) (BMNH); 1 ♀, Bartica District (AMNH, New York); 1 ♀, 1 ♂, Kartabo, Bartica District (AMNH, New York); 1 ♀, same data (MCZ, Harvard); 1 ♀, Tumatumari (BPBM, Honolulu); 1 ♀, no further data (BMNH); 1 ♀, Kamakusa (AMNH, New York). TRINIDAD: 1 ♀, Morne Bleu, 2700 ft (CNC, Ottawa). SURINAM: 2 ♀, Coppename River, Raleigh Falls; 1 ♀, Nassau Mts; 1 ♀, Lelydorp, Sumatraweg, Malaise Trap; 1 ♀, Mapane area; 1 ♀, Paramaribo (RNH, Leiden); 1 ♀, Paramaribo (BMNH); 3 ♀, no further data (1 RNH, Leiden; 2 MNHU, Berlin). FRENCH GUIANA: 2 ♀, Mana River (CM, Pittsburgh); 1 ♀, 'Nouveau Chantier'; 1 ♀, St Laurent du Maroni; 1 ♀, Charvein; 1 ♀, 'Haut-Carsevenne'; 1 ♀, St Georges; 1 ♀, St Laurent du Maroni (MCZ, Harvard); 6 ♀, no further data (2 MNHN, Paris; 2 NM, Vienna; 1 UZM, Copenhagen & 1 FSAE, Gembloux). BRAZIL: 1 ♂, São Paulo de Olivença (BMNH); 1 ♀, Amazonas, Tefé (ZSBS, Munich); 1 ♀, 1 ♂, Amazonas, Villa Nova (BMNH); 1 ♀, Amazonas, Manaos (MCZ, Harvard); 1 ♀, 1 ♂, Amazonas (ZSBS, Munich); 1 ♀, Amazonas, Rio Purus (NR, Stockholm); 1 ♂, Amazonas, Fonte Boa (Menke coll.); 1 ♀, Amapá, Serra do Navio (Fritz coll.); 22 ♀, Pará, Belém (4 CU, Ithaca; 6 MP, Belém; 3 ZSBS, Munich; 2 NM, Vienna; 1 MNHU, Berlin; 1 MIZSU, Turin; 1 MNHN, Paris; 3 BMNH & 1 UM, Oxford); 1 ♂, Pará, Belém (MP, Belém); 1 ♀, Pará, Belém, Faz. Velha (MP, Belém); 1 ♀, Pará, Faro (MP, Belém); 1 ♀, Pará, 'Jabaty' (BPBM, Honolulu); 5 ♀, Pará, Santarém (2 Menke coll.; 3 CM, Pittsburgh); 1 ♀, Pará, Maruru near Santarém (CM, Pittsburgh); 1 ♂, same data (Menke coll.); 3 ♀, Amazon, no further data (2 UM, Oxford; 1 NM, Vienna); 1 ♀, 2 ♂, Maranhão, Alcantara (MP, Belém); 2 ♀, Piauí (TM, Budapest); 1 ♀, Pernambuco, Recife (MNHN, Paris); 1 ♀, Bahía, Salvador (NM, Vienna); 1 ♀, Rio de Janeiro, Niteroi (NM, Rotterdam); 1 ♀, near Rio de Janeiro (NM, Vienna); 1 ♀, 'Monat' (USNM, Washington); 2 ♀, no further data (UM, Oxford & TM, Budapest); 1 ♂, no further data (MHN, Geneva); 4 ♀, no data (3 NM, Vienna & 1 UM, Oxford).

* 'Bogota' must here be regarded as an over-generalized locality. The height of this city is well above the upper altitude limit of the genus.

Trigonopsis cameronii (Kohl)

(Figs 1, 40, 69, 70, 98)

[*Trigonopsis violaceus* Smith; Cameron, 1888 : 26, pl. 2, fig. 13. Misidentification.]

Podium (*Trigonopsis*) *abdominale* var. *cameronii* Kohl, 1902 : 29, 37. Lectotype ♀, PANAMA (NM, Vienna), by designation of Menke *in* Bohart & Menke, 1976 : 98 [examined].

Trigonopsis cameronii (Kohl); Richards, 1937 : 107, 112, ♀.

LECTOTYPE. Menke *in* Bohart & Menke (1976 : 98) designated as lectotype of *cameronii* a female specimen from Panama bearing Cameron's label '*Trigonopsis violaceus* Smith ?' and Kohl's label '*Tr. abdominalis* var. *Cameronii*'. It is not known how this specimen came to be in NM, Vienna, but it is part of the original *Biologia Centrali-Americana* material. This is not discussed by Menke, and neither are the three paralectotypes (which I have so labelled): 1, a female labelled 'Bogota', also bearing Kohl's labels '*Trigonopsis abdominalis* var. *Cameronii* K. det. Kohl' and 'cf. *Trigonopsis violaceus* Smith !'; 2, a female from French Guiana bearing Kohl's label '*Trigonopsis abdominalis* var. *Cameronii* K. det. Kohl' and Menke's labels 'Syntype: *Podium abdominale cameronii* Kohl (but not *cameronii*). Desig. A. S. Menke' and '*Trigonopsis violascens* D. T.'; 3, a female from Guatemala which together with the lectotype formed Cameron's original *Biologia* material. It was labelled by him '*Trigonopsis violaceus*' and is the figured specimen, as evidenced by the scale line.

♀. BL 14–18 (but see below). Almost entirely dark, with violet-blue reflections, especially on head and gaster. Pronotum without dorsal projection. (Fig. 1.) HW 2·6–3·1, HL 2·7–3·3, HR 0·9–1·0, EL 1·9–2·2, UIW 1·3–1·5, MIW 1·5–1·7, LIW 1·2–1·4, CTW 0·65–0·80, TOD 0·45–0·60, CR 1·3–1·6, MBL 1·2–1·7, MAL 0·65–0·95, MR 1·5–2·1, PDL 1·6–2·1, PL 2·4–3·2, PR 1·4–1·6. A very large specimen from Colombia, Anchicaya differs as follows: BL 21, HW 3·7, HL 3·7, EL 2·5, UIW 1·8, MIW 2·0, LIW 1·7, MBL 1·9, MAL 1·05, MR 2·4, PL 3·5. Otherwise like *rufiventris* ♀.

♂. BL 14·0–16·0. Colour as ♀. Genitalia as in Figs 69, 70. HW 2·6–2·8, HL 2·6–3·0, HR 0·9–1·0, EL 1·8–2·0, UIW 1·4, MIW 1·5–1·6, LIW 1·2–1·3, CTW 0·25–0·30, CED 0·30–0·32, CER 0·8–1·0, TOD 0·57–0·65, CR 0·4–0·5, PDL 1·7–2·0, PL 3·0–3·4, PR 1·6–1·8. (Fig. 40.) Otherwise as *rufiventris* ♂.

This species resembles *violascens* in colour, but is not sympatric with it. Also, it resembles *rufiventris* in structure. However, the constant colour differences, the different averages of variation as noted below, and their allopatric distribution, added to the fact that only small differences separate other species of the group, all appear to justify treating *cameronii* as a good species.

VARIATION. Rarely, one of the female clypeal teeth may be slightly bifid. Only one of the eight males examined has the inner edge of the mandible with a rather weak preapical expansion, the others entirely lack it (cf. *violascens*). This species exhibits less variation than *rufiventris*, its closest relative, and the ranges of variation only partly overlap. The average size of *cameronii* is smaller and the ranges of clypeal ratio and petiole ratio in the females are not as great. In the males, the ranges of all the ratios except head ratio are smaller. The genitalia are less variable and on average smaller and more heavily pigmented.

DISTRIBUTION. Mexico southwards to the west coast of Ecuador, and eastwards to the Sierra Nevada de Santa Marta on the Caribbean coast of Colombia. It is separated from all other species of the genus by the Andes (map, Fig. 98).

The species inhabits various types of forest which vary considerably in degree of humidity.

Kohl did not see Smith's type of *violaceus* (= *violascens*) (a normal male), which had not been illustrated. He correctly referred to *violascens*, only this type-specimen and an aberrant male. He described an aberrant female as *resplendens*, while referring a normal female (from French Guiana) to *cameronii*. Thus Kohl had confused the two species. Since he was also misled by a true *cameronii* mislabelled 'Bogota', he was unable correctly to state the distribution of the two species.

BIOLOGY. Rau (1933 : 182) (Panama, Barro Colorado Island) records finding a nest of four cells on a tree trunk, 0·35 m from the ground.

Eberhard (1972 ; 1974) has given a comprehensive account of this species' biology, including a primitive kind of sociality, in Colombia, near Cali. The nests consisted of 1–129 cells, often including many old, disused ones, attached to rock-faces. After completion, the cells were incom-

Fig. 98 Collection localities of *T. cameronii.*

pletely covered with rough mud. Cockroaches (*Riatia fulgida* (Saussure), *Chorisoneura translucida* (Saussure) and *Amazonina* n. sp. (det. Gurney)) were used as prey. Parasites were: *Photocryptus* sp. (Ichneumonidae), *Gilvella* sp. (Tachinidae) (possibly on the roaches) and *Macrosiagon lineare* (Le Conte) (Rhipiphoridae).

Cooper found a nest at Colombia, Magdalena, Sierra Nevada de Santa Marta, Rio Don Diego: of two complete cells, measuring about 25 mm high and 25 mm wide, attached to hanging rootlets. A wasp was adding pellets to the outside of the nest, giving it a rough appearance.

Cooper informs me that the cocoon of this species resembles that of *violascens* (Figs 36, 37).

MATERIAL EXAMINED. Dates and collectors' names omitted.

Podium (*Trigonopsis*) *abdominale* var. *cameronii* Kohl, lectotype ♀, PANAMA: Chiriqui, David (NM, Vienna).

MEXICO: 1 ♀, Tabasco, Teapa (BMNH); 1 ♀, Chiapas, Finca Cucalhuitz, 19 km E. Bochil (Menke coll.); 2 ♀, Chiapas, Ruta 190, 21 km E. Cintalapa; 1 ♀, no further data (USNM, Washington). GUATEMALA: 1 ♀, Alta Vera Paz, San Juan (paralectotype of *cameronii*) (BMNH); 1 ♀, Escuintla, El Salto (BPBM, Honolulu); 1 ♀ no further locality, 300 m (AMNH, New York). EL SALVADOR: 1 ♀, Los Chorres (CU, Davis). NICARAGUA: 1 ♀, Managua (Menke coll.). COSTA RICA: 1 ♀, Golfito (CMNH, Los Angeles); 2 ♀, no further data (TM, Budapest). PANAMA: 6 ♀, Taboga Island (3 USNM, Washington; 1 TM, Budapest & 2 UZM, Copenhagen); 1 ♂, same data

(USNM, Washington); 6 ♀, Barro Colorado Island (2 CU, Davis; 1 AMNH, New York; 2 USNM, Washington & 1 Menke coll.); 1 ♀, Chiriqui (TM, Budapest); 1 ♀, Cerro Campana (USNM, Washington). COLOMBIA: 3 ♀, 4 ♂, Valle, Cali, 1000 m (USNM, Washington); 1 ♀, same data (TM, Budapest); 1 ♀, 1 ♂, Valle, Rio Jamundi between Cali and Jamundi, 1000 m (BMNH); 1 ♀, Valle, Cent. Anchicaya, 400 m (BMNH); 2 ♀, same data (USNM, Washington); 8 ♀, Nariño, Barbacoas, 80 m; 2 ♀, Magdalena, N. Sierra Nevada de Santa Marta, Rio Don Diego (BMNH); 1 ♀ [Magdalena ?] Minca (CM, Pittsburgh); 1 ♀, 'Bogota' (see footnote p. 135) (paralectotype of *cameronii*) (MNHU, Berlin); 1 ♀, 'Cananche' (BMNH); 1 ♂, 'Sierra San Lorenzo' (TM, Budapest). ECUADOR: 1 ♂, Guayas, Bucay (*c.* 200 m) (BPBM, Honolulu); 1 ♀, Balzapamba (1.47 S., 79.13 W., *c.* 200 m) (MNHU, Berlin). 1 ♀, no data [mislabelled 'Surinam'] (UZM, Copenhagen).

Trigonopsis howesi sp. n.

(Figs 73, 74, 99)

[*Trigonopsis abdominalis* Perty; Howes, 1969 : 36–37, pl. 13b. (Det. Rohwer.) Misidentification.]

♀. BL 19–20. Pronotal dorsum without projection, but with a shallow but distinct longitudinal groove. Gaster red. Petiole of even width. HW 3·4, HL 3·5, HR 1·0, EL 2·4, UIW 1·6, MIW 1·8, LIW 1·6, CTW

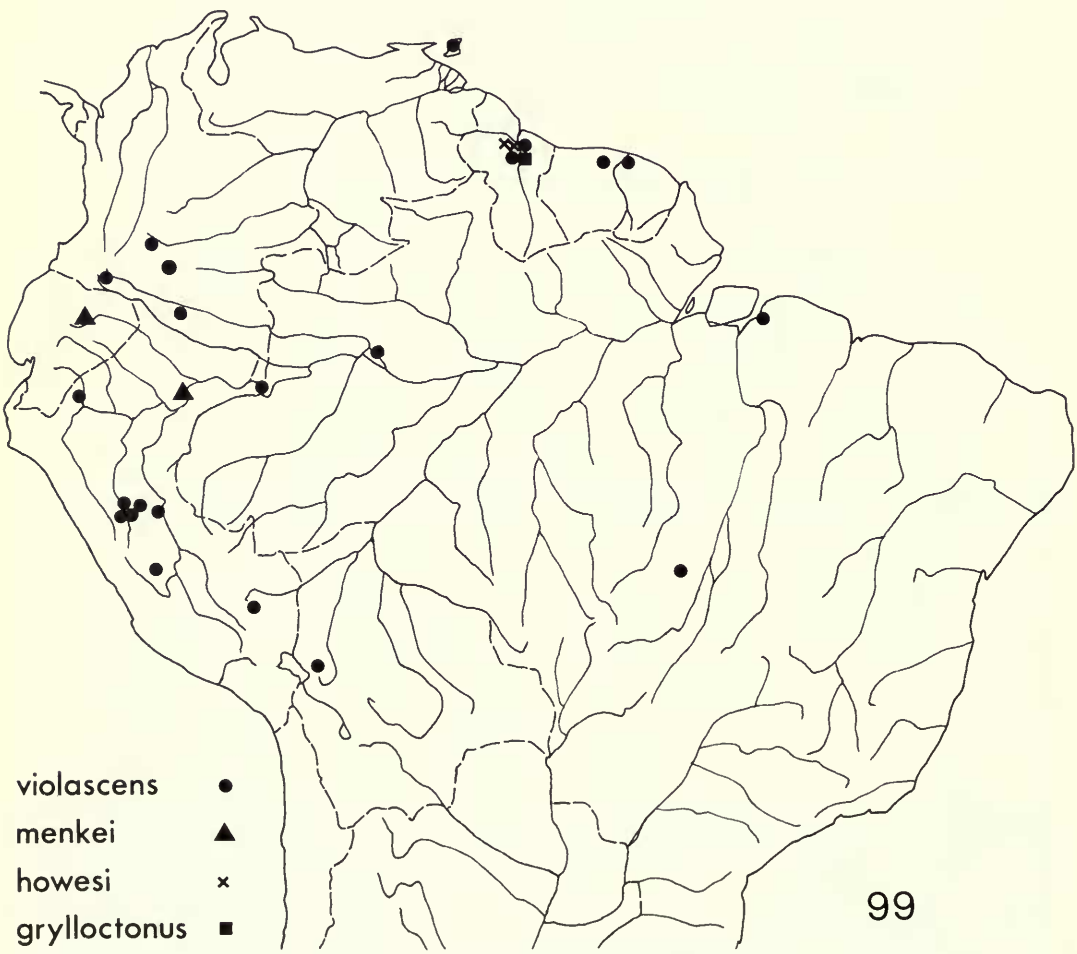


Fig. 99 Collection localities of some *T. rufiventris*-group species.

0·85, TOD 0·80, CR 1·1, MBL 1·8, MAL 1·0, MR 1·8, PDL 2·2, PL 3·3–3·4, PR 1·5. Otherwise as *rufiventris* ♀.

♂. BL 16·5. Pronotal dorsum with moderately distinct longitudinal groove. Genitalia as in Figs 73, 74. HW 3·0, HL 3·2, HR 0·9, EL 2·2, UIW 1·5, MIW 1·6, LIW 1·4, CTW 0·32, CED 0·3, CER 1·1, TOD 0·72, CR 0·4, PDL 2·1, PL 3·4, PR 1·6. Otherwise as *rufiventris* ♂.

This species differs structurally from *rufiventris* only in its pronotal groove and genitalia.

VARIATION. None observed.

DISTRIBUTION. Guyana only (map, Fig. 99).

BIOLOGY. This species builds an extraordinary nest. Howes (1969 : 36–37) states that it was attached to the underside of a palm frond and consisted of 4–5 horizontal cells placed one beside each other. These were enclosed in a thin shell-like globe of clay, surmounted by several half-globes, concave side down, decreasing in size upwards and in contact at least behind. Howes (pl. 13c) gives a good photograph of one such nest (with four half-globes) and told me in correspondence that he found a total of five such nests. The reason for the extremely elaborate additions is obscure. Howes states that cockroaches were used as prey.

MATERIAL EXAMINED. Holotype ♀, GUYANA: Kartabo near Bartica, 26.ii.1922, reared (*Howes*) (*abdominalis* det. Rohwer) (BMNH).

Paratypes. GUYANA: 1 ♂, same data as holotype but 27.ii.1922 (BMNH); 1 ♀, Mazaruni River, Kalacoon, 3 mi. from Bartica, 1961 (*Howes*) (*abdominalis* det. Rohwer) (USNM, Washington).

Trigonopsis grylloctonus Richards

(Figs 49–51, 75, 76, 99)

Trigonopsis grylloctonus Richards, 1937 : 110. Holotype ♂, GUYANA (BMNH) [examined].
Trigonopsis grylloctonus Richards; Menke *in* Bohart & Menke, 1976 : 98.

♀. Unknown.

♂. BL 13·0. Pronotal dorsum without projection and without longitudinal groove. Gaster red. Petiole considerably thickened in middle (Figs 49, 50). Genitalia as in Figs 75, 76. HW 2·3, HL 2·3, HR 1·0, EL 1·6, UIW 1·2, MIW 1·3, LIW 1·0, CTW 0·22, CED 0·20, CER 1·1, TOD 0·50, CR 0·4, PDL 1·4, PL 2·3, PR 1·6, Fig. 51. Otherwise as *rufiventris* ♂.

The male of this species differs from that of *rufiventris* only in petiole shape and genitalia.

VARIATION. Unknown.

DISTRIBUTION. Guyana only (map, Fig. 99).

BIOLOGY. Richards (1937 : 111) describes a mud nest found under a leaf, attached to the midrib near the base. The nest was ovoid, 30 × 20 × 17 mm deep, including the overall mud covering. One cell was still open and contained a cricket. Later, the male wasp emerged from the only other cell.

This is the only species so far known to select prey other than cockroaches.

MATERIAL EXAMINED. Holotype ♂, GUYANA: Essequibo River, Moraballi Creek (*c.* 30 km SE. Bartica), 25.ix.1929, reared (BMNH).

The *vicina*-group

Pronotum with dorsal projection. Propodeum with dorsal rugae also outside the central furrow. Males with strongly flattened antennae, with some segments expanded. The male clypeal structure of the three species represents various degrees of development of a basic pattern. Cuspis of genitalia with basal post round-ended. Female mandible with U- to V-shaped notch, upper edge of apex inflexed. Female clypeus with 5 usually sharp teeth (centre one occasionally reduced or absent). Sternite 6 sharply keeled.

The females of *vicina* and *schunkei* are very similar, having an unusually long third antennal segment, almost identical clypeal teeth and long, slender mandibles. The female of *richardsi* is very different, but its male strongly links it to the other species of the group; in addition, the female has a pronotal projection; mesoscutal pubescence; and HR of 1·0 in common with all males of the group.

Trigonopsis richardsi sp. n.

(Figs 29–32, 55, 57, 81, 82, 100)

[*Trigonopsis affinis* Smith; Richards, 1937 : 107. ♀ variety, ♂. Misidentification.]

♀. BL 13–17. Mandible usually sharply bent at the notch, inner margin ± strongly expanded before it, slender but rather abruptly tapered after it. Upper margin of apex strongly inflexed, especially near notch. Notch V-shaped, narrow but deep, right-angled distally, shallowly rounded proximally. Clypeus with 2 large teeth and 3 smaller ones between, usually all straight, centre one sometimes reduced or absent. HW 2·8–3·5, usually exactly equal to HL (at most 0·1 wider in some larger specimens). Occipital carina ± expanded into a thin, lamellar flange, but not as broadly as in *rufiventris*-group species. (Figs 29–32.) Pubescence usually dense on anterior half of mesoscutum. HL 2·8–3·4, HR always 1·0, EL 1·8–2·2, UIW 1·5–1·8, MIW 1·7–2·0, LIW 1·3–1·8, CTW 0·7–1·1, TOD 0·4–0·6, CR 1·2–2·3, MBL 1·2–2·0, MAL 0·3–0·7, MR 2·4–3·4 (–3·8), PDL 1·7–2·1, PL 2·1–2·7, PR 1·1–1·4.

♂. BL 13–15. Antennal segments 2–6 dorsoventrally flattened, 5 & 6 slightly expanded on outer side. Segment 2 is 1·6–1·7 times longer than wide (Fig. 57). Mandibular inner margin with small but deep basal emargination. Clypeus with 2 large, sharp teeth, its tooth-to-orbit margin interrupted by a deep notch. Sides of notch produced into tubercles behind, outer one connected to a third tubercle still further back (Fig. 55). Genitalia as in Figs 81, 82. HW 2·7–2·8, HL 2·7–2·8, HR always 1·0, EL 1·7–1·9, UIW 1·4–1·5, MIW 1·6–1·7, LIW 1·3–1·5, CTW 0·40, CED 0·32–0·35, CER 1·1–1·2, TOD 0·65–0·70, CR 0·6, PDL 1·5–1·6, PL 2·3–2·4, PR 1·4–1·5. Otherwise as female, except mesoscutal pubescence not very dense.

The smallest red and black species with a pronotal dorsal projection. Both sexes have a rather broad occipital flange. Usually the females are well distinguished by mandibular shape, typically like that of most *rufiventris*-group species, but variants with weak mandibular development are more difficult to identify. However, the HR of 1·0 is still distinctive. The male resembles that of *vicina* but has fewer antennal segments expanded and three subclypeal tubercles instead of two.

VARIATION. Female variation is complicated and often extreme. The mandibular ratio varies greatly, independently of specimen size. The mandibular expansion varies from slight to very strong with a rounded, obtuse angle. When the expansion is slight, the notch is very small. Most frequently in small specimens, reduction of the centre tooth of the clypeus is accompanied by a narrowing of the gap between the adjacent pair (cf. Figs 29 & 32). Only in some small specimens, the tooth-bearing area is very prominent but strongly emarginate, so that the three centre teeth are effectively much shorter than the outermost pair (Fig. 29). The deeper the clypeal emargination, the broader and more angular is the mandibular expansion. A small female from Venezuela entirely lacks the centre tooth and has the tooth-bearing area prominent, but this is not emarginate and the mandibular expansion is slight (Fig. 30). This specimen is the only one seen which has the clypeal teeth slightly bent forward. A female from Peru, Pucallpa, 22.vi.1960, has the centre tooth very reduced and the other four longer than usual, the head strongly expanded posteriorly, and the mandibular expansion slight (Fig. 31). In this specimen all the interocular widths are abnormally large for the head width: upper 2·0, middle 1·8, lower 2·0, head width 3·2. Even two other specimens with head width 3·3 have all the interocular widths smaller (one has the inner orbits parallel, the other has them slightly divergent downwards). (See also *vicina* variation.)

If there were not so much material available of this species (nineteen females) it would be easy to believe that the striking extremes of variation represented distinct species.

DISTRIBUTION. This appears to be mainly a western and northern species, less frequent in the east (map, Fig. 100).

BIOLOGY. Unknown.

MATERIAL EXAMINED. Holotype ♀, PERU: Loreto, Pucallpa, 28.vi.1960 (*Schunke*) (BMNH).

Paratypes. PERU: 5 ♀, same data as holotype but 2, 22.vi.1960; 1, 11.i.1961; 1, 24.xi.1962 (BMNH); 1, 180 m, 19.vi.1971 (USNM, Washington); 2 ♂, same data but 5.vii.1951 & 6.i.1962 (BMNH); 1 ♀, Junín, Satipo, 750 m, 15.i.1938 (*Lindemans*) (NM, Rotterdam); 1 ♀, Huánuco, Tingo Maria, Rio Huallaga, 700 m, 15.i.1947 (*Weyrauch*) (IML, Tucumán); 1 ♀, San Martín, Moyobamba region, 8.i.1926 (*Bassler*) (AMNH, New York). COLOMBIA: 1 ♀, Vaupes, Miraflores, 400 m, 31.i–5.ii.1972 (*Cooper*) (BMNH); 2 ♀, Putumayo, Mocoa, 18.iv.1974 & 31.iii.1976 (*Cooper*)

(BMNH). VENEZUELA: 1 ♀, Bolívar, Surukum, xii.1940 (*Anduze*) (CU, Ithaca). GUYANA: 1 ♀, Essequibo River, Moraballi Creek (*c.* 30 km SE. Bartica), 1929 (*Richards*) (BMNH) (Richards' *affinis* variety); 1 ♀, Bartica (NM, Vienna). BRAZIL: 1 ♀, Piauí (TM, Budapest); 1 ♂, Amazonas, São Paulo de Olivença (*Bates*) (BMNH) (Richards' ♂ *affinis*); 1 ♀, Amazonas, Rio Purus, January (*Roman*) (NR, Stockholm). BOLIVIA: 2 ♀, Beni ('Pando' on label), Guayaramerin, xii.1956 (*Fritz*) (Fritz coll.).

Trigonopsis vicina (Dalla Torre)

(Figs 21, 58, 60, 83, 84, 100)

Trigonopsis affinis Smith, 1851 : 31 (part). LECTOTYPE ♀, BRAZIL (BMNH), here designated [examined]. [Junior secondary homonym in *Sceliphron* Klug of *Sphex affinis* F., 1793.]
Sceliphron vicinum Dalla Torre, 1897 : 392. [Replacement name for *Trigonopsis affinis* Smith.]
Trigonopsis affinis Smith; Richards, 1937 : 107, 111, ♀ (part).

LECTOTYPE DESIGNATION. Smith described *affinis* from specimens collected by Wallace and Bates. One syntype in the BMNH collections agrees with Smith's description and locality, and with the current interpretation of the species. A second syntype in the collections of UM, Oxford, does not agree with the description or locality, and is identified as the species here described as *cooperi*. I have labelled, and here designate as lectotype, the female in the collections of the BMNH.

♀. BL 16–19. Mandible slender, evenly curved. Mandibular notch formed by an oblique incision where the inflexed upper margin of the apex is twisted under the upper margin of the basal part, with the basal angle of the notch more shallowly obtuse than the distal. Clypeus with 5 usually well-formed teeth, outermost pair the longest, the centre one equal to or slightly longer than the adjacent pair (Fig. 21). Antennal segment 3 is 2·5–2·8 times as long as 6. MIW 2·2–2·4 times CTW. HW 3·1–3·7, HL 2·9–3·4, HR always 1·1, EL 1·9–2·2, UIW 1·6–1·9, MIW 1·8–2·2, LIW 1·5–1·8, CTW 0·8–0·9, TOD 0·5–0·7, CR 1·3–1·6, MBL 1·7–2·1, MAL 0·3–0·7, MR 2·7–3·2 (–5·6), PDL 1·7–1·9, PL 2·5–2·8, PR 1·4–1·6.

♂. BL 16·5–19·0. Antennal segments 2–12 rather strongly dorsoventrally flattened, segments 5–10 strongly expanded on outer side. Segment 2 about as long as wide (Fig. 58). Extreme base of mandibular inner margin scarcely emarginate. Clypeus with 2 large, sharp teeth. Base of outer side of each tooth tuberculate behind. Behind the tooth-to-orbit margin, but not forming part of it, is another tubercle whose tip is just visible in front view. Together with the other tubercle it forms the sides of a deep notch. There is no third tubercle behind the outer one (Fig. 60). Very similar to male *neotropica* (Fig. 54). Occipital fossa width 1·2 (–1·8). Eyes convergent downwards. Genitalia as in Figs 83, 84. HW 3·0 (–4·1), HL 3·0 (–3·8), HR 1·0 (–1·1), EL 1·9 (–2·4), UIW 1·6 (–2·2), MIW 1·8 (–2·4), LIW 1·4 (–2·2), CTW 0·35 (–0·80), CED 0·35 (–0·60), CER 1·0 (–1·3), TOD 0·75 (–0·90), CR 0·5 (–0·9), PDL 1·8 (–2·3), PL 2·9 (–3·2), PR (1·4–) 1·6. Otherwise as female.

The female is similar to that of *schunkei*, the most obvious difference being the much greater MR of *vicina*. The male is very like that of *neotropica* in clypeal structure, but differs mainly in that some of the antennal segments have lateral expansions.

VARIATION. A large female from Trinidad, although its head width (3·5) is not the largest, has the head posteriorly expanded more than that of any other specimen, and is reminiscent of the Pucallpa specimen of *richardsi* (p. 140). Apart from this and the central clypeal tooth, there is little variation in females.

In the absence of more specimens better to show the range of variation, the male from Marajó is placed here only tentatively. Although its genitalic structure readily distinguishes it from *neotropica*, the structure of the clypeus and antennae of this very large individual are modified such as to make its separation from *richardsi* difficult.

DISTRIBUTION. Sparingly from the Amazon northwards (map, Fig. 100).
BIOLOGY. Unknown. Williams reared a male in 1923 (the only reared specimen of the species-group) but regrettably gave no details in his 1928 paper.

MATERIAL EXAMINED. *Trigonopsis affinis* Smith, lectotype ♀, BRAZIL: Pará, Belém (*Wallace & Bates*) (BMNH).

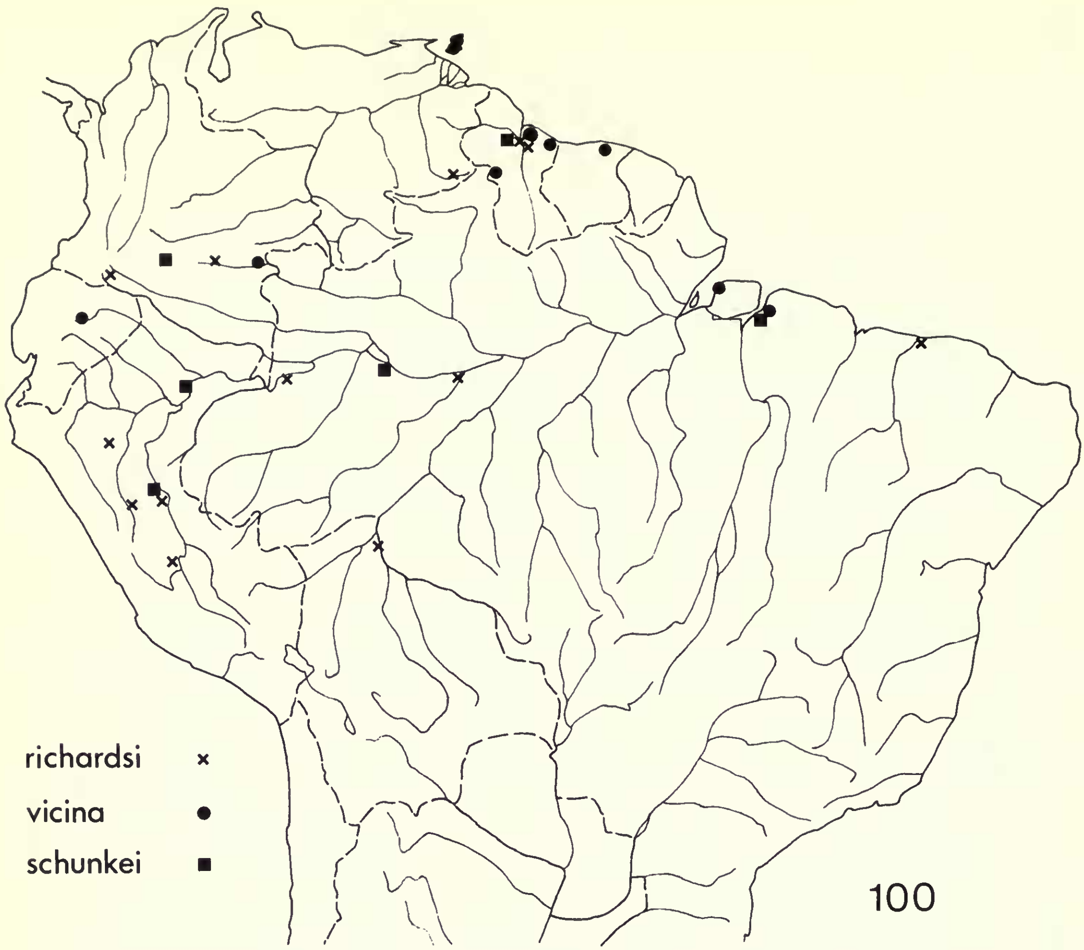


Fig. 100 Collection localities of the *T. vicina*-group.

COLOMBIA: 1 ♀, Vaupes, Mitú, 17.v.1974 (*Cooper*) (BMNH). ECUADOR: 1 ♀, Napo, Napo, viii–ix.1931 (*Benoist*) (MNHN, Paris). TRINIDAD: 1 ♀, Diego Martin, 21.i.1942 (*McC. Callan*) (USNM, Washington); 1 ♀, Arima Valley, 21.vi.1951 (Menke coll.). GUYANA: 1 ♀, ix.1923; 1 ♂, reared 12–13.xi.1923, Blairmont Plantation, Berbice County (*Williams*) (BPBM, Honolulu); 1 ♀, Pakaraima Mts, Upper Ireng River, 1932 (*Myers*) (BMNH); 1 ♀, Demerara (MCZ, Harvard). SURINAM: 1 ♀, Paramaribo, Charlesburg, 16–18.i.1964, Malaise trap (*Geijskes*) (RNH, Leiden). BRAZIL: 1 ♂, Pará, Ilha do Marajó, R. Anajas, 13.vi.1900 (*Ducke*) (MP, Belém).

Trigonopsis schunkei sp. n.

(Figs 26, 52, 56, 79, 80, 100)

♀. BL 18–22. Mandible slender and evenly curved. Mandibular notch only slightly oblique, inflexed upper margin of apex cut off perpendicularly well short of rounded end of upper margin of base, so that a broad, deep notch is formed. Antennal segment 3 is 2·9–3·3 times as long as 6. MIW 1·7–2·1 times CTW. Clypeus with 5 usually well-formed teeth, the outermost pair the longest and the centre one equal to or shorter than the adjacent pair (Fig. 26). HW 3·7–4·4, HL 3·1–3·6, HR 1·1–1·2, EL 2·0–2·4, UIW 1·9–2·2, MIW 2·1–2·5, LIW 1·9–2·3, CTW 1·1–1·2, TOD 0·6–0·7, CR 1·6–2·1, MBL 2·1–2·6, MAL 1·0–1·2, MR 1·9–2·3, PDL 2·0–2·4, PL 3·0–3·3, PR 1·3–1·5.

♂. BL 15·0–16·5. Antennal segments 2–8 strongly flattened dorsoventrally, segments 4–8 moderately expanded on outer side. Segment 2 a little longer than wide (Fig. 56). Inner mandibular margin with a sub-basal tooth. Clypeus produced into two large, rectangular, divergent lobes, with a shallow emargination at the end of each, and a broad, deep one between. Lobe-to-orbit margin with a deep notch, the lobe side of which is strongly carinate behind, with an unconnected tubercle further back (only visible in ventral view) (Fig. 52). Genitalia (Figs 79, 80). HW 3·1–3·5, HL 3·1–3·5, HR 1·0, EL 1·9–2·1, UIW 1·8–2·0, MIW 1·9–2·2, LIW 1·7–2·0, PDL 1·7–1·8, PL 2·3–2·4, PR 1·3. Otherwise as female except pubescence very dense on anterior half of mesoscutum.

The female is very similar to that of *vicina* but has a much smaller mandibular ratio as well as other more detailed differences. The male has a unique clypeal shape.

VARIATION. Apart from the centre tooth of the female clypeus, the back of the head in the Pucallpa 1.v.1959 male is very strongly expanded, that of the other one scarcely so.

DISTRIBUTION. Amazon Basin and Guianas; uncommon (map, Fig. 100).

BIOLOGY. Unknown. Cooper noted an offensive smell produced by the female of this species when caught, although it was less strong than that of *succinea*.

MATERIAL EXAMINED. Holotype ♀, PERU: Loreto, Pucallpa, 3.vii.1960 (*Schunke*) (BMNH).

Paratypes. PERU: 1 ♀, same data as holotype but 20.ii.1963 (BMNH); 2 ♂, same data as holotype but 1.v.1959 (BMNH) and 2.iii.1948 (USNM, Washington); 1 ♀, Loreto, Iquitos, San Roque, iv.1929 (*Klug*) (CU, Ithaca). COLOMBIA: 1 ♀, Meta, La Macarena 29.x–7.xi.1976 (Cooper) (BMNH). GUYANA: 1 ♀, Mazaruni (*c*. 10 km NW. Bartica), 2nd growth (low forest), 27.xi.1937, no. 346 (*Richards & Smart*) (BMNH). BRAZIL: 2 ♀, Amazonas, Tefé (*Bates*) (ZSBS, Munich); 1 ♀, Pará, Belém, 1846 (*Ghiliani*) (MIZSU, Turin); 2 ♀, Pará, Belém, 6.v.1902 & 23.vi.1903 (*Ducke*) (MP, Belém).

The *intermedia*-group

Pronotum with sharply angulate dorsal projection. Propodeum with dorsal rugae also outside central furrow. Female mandible very stout, nearly straight and parallel-sided almost to the U-shaped notch. Notch always large, mandibular outer margin strongly curved around it. Upper margin of apex broadly inflexed, especially near the notch, abruptly tapered. Clypeus with 2 large teeth and 4 or 5 smaller, blunt, often irregular teeth between. Male clypeus with 2 large, sharp, simple teeth, and the tooth-to-orbit margin entire. Antennal segments cylindrical. Cuspis of male genitalia with basal post round-ended.

The females of *intermedia* and *cyclocephalus* are very similar. They are larger than *moraballi*, with the clypeal teeth more numerous and more irregular, the mandible less strongly curved, its apex less slender, the notch overhung by a carina and the upper edge of both base and apex inflexed.

Trigonopsis intermedia Saussure

(Figs 14, 15, 62, 63, 87, 88, 101)

Trigonopsis intermedius Saussure 1867 : 33, pl. 2, fig. 18. Holotype ♀, BRAZIL (NM, Vienna) [examined].
[*Podium* (*Trigonopsis*) *affine* Smith; Kohl, 1902 : 34, part. Misidentification.]

♀. BL 22–27. The largest known species of the genus, and the only species lacking a basal spine on the mandibular inner margin (reduced to an inconspicuous tubercle). Mandible very stout, most of the base slightly curved and parallel-sided, strongly curved from shortly before the notch to beyond it. Near the notch, apical upper margin broadly inflexed, basal very narrowly. Notch large, right-angled distally, obtuse proximally, partly overhung by a strong carina. Clypeus with the outermost pair of teeth fairly large, outwardly directed and strongly bent forward. Between them are 4 much smaller, often irregular, teeth. The central gap (usually the widest) sometimes has a vestigial, blunt, seventh tooth (Figs 14, 15). HW 4·4–5·2. HL 3·4–4·0, HR 1·2–1·3, EL 2·5–3·0, UIW 2·0–2·3, MIW 2·5–2·9, LIW 2·3–2·7, CTW 1·5–1·8, TOD 0·5–0·7, CR 2·6–3·4, MBL 2·4–3·3, MAL 0·7–1·1, MR 2·6–3·4 (–3·9), PDL 2·5–3·1, PL 2·6–3·2, PR 1·0–1·1.

♂. BL 19·5–23·0. Mandibular inner margin with sub-basal tooth. Clypeus with the 2 teeth widely separated, their tips often bent outwards. Head ± strongly expanded posteriorly (Figs 62, 63). Genitalia as in Figs 87, 88. HW 3·9–4·5, HL 3·5–4·1, HR 1·1, EL 2·4–2·7, UIW 1·9–2·3, MIW 2·3–2·7, LIW 2·2–2·5. CTW 0·90–1·05, CED 0·52–0·67, CER 1·4–1·7, TOD 0·92–1·10, CR 0·9–1·1, PDL 2·2–2·8, PL 2·9–3·6, PR 1·1–1·4. Otherwise as female.

The largest species. The female is very similar to that of *cyclocephalus*, but lacks the mandibular spine. The males of both this species and *schunkei* have a mandibular tooth, but the clypeal shape is quite different.

VARIATION. The temples of the male may be ± strongly expanded, and the tips of the clypeal teeth are sometimes bent outwards. The clypeal teeth of females are irregular as detailed above.

DISTRIBUTION. Fairly common in the Guianas, less so on the eastern coast of Brazil (as far as Rio de Janeiro ?) (map, Fig. 101).

TYPE-LOCALITY. The original description and label both give only Brazil. According to the report of the voyage, the ship *Novara* called in Brazil only at Fernando Noronha Island and Rio de Janeiro. The latter seems the most likely to be the type-locality, especially since at that time the coastal rain-forest was continuous with that further north, where all other specimens were collected.

BIOLOGY. Richards (1937 : 107) states that the female taken at Moraballi Creek on 22.x.1929 was carrying a cockroach up a hollow in a Mora tree.

The following notes were made in Guyana by Professor Richards during the 1937 expedition. They refer to nests examined or collected at Mazaruni (*c.* 10 km NW. Bartica). '2 nests 19.viii.1937, the first on underside of sloping, living tree, 1 ft from ground, in secondary growth. 2 cells, 1 empty, the other with a wasp. The second nest about an inch from the first, 4 cells.'

'Several groups of cells 25.viii.1937 on buttress of old Mora tree. First group very old, occupied by termites. Second group, 2 cells, 1 with a cockroach, with an egg in front of mid coxae, the other with 2 cockroaches and a larva 10 mm long (one prey still intact, constantly moved all its palpi). Third group, 3 cells, one with 4 cockroaches. Preserved. [Now lost.] One cockroach with a larva 4 mm long between fore and mid coxae. All more or less alive, one almost able to walk. Another cell with a larger larva, another with a cocoon. Fourth group, 2 cells. Both with cocoons.'

The above nests produced wasps as detailed in 'Material examined', both sexes from some nests.

MATERIAL EXAMINED. Holotype ♀, BRAZIL (Rio de Janeiro ?) (*Novara Expedition*) (NM, Vienna).

GUYANA: 2 ♀, Essequibo River, Moraballi Creek (*c.* 30 km SE. Bartica), 29.viii & 22.x.1929 (*Oxford University Expedition*) (BMNH); 1 ♀, 2 ♂, Mazaruni (*c.* 10 km NW. Bartica), 2nd growth (low forest), 19.viii.1937, reared (*Richards & Smart*); 3 ♀, 2 ♂, same data but 25.viii.1937, reared (BMNH); 1 ♂, Demerara (*Ballion*) (IRSNB, Brussels); 1 ♀ (*Rodway*); 2 ♀ (*Bartlett*); 1 ♂ (*Cameron*), all without further data (BMNH). SURINAM: 2 ♀ without further data (1, FSAE, Gembloux; 1, TM, Budapest). FRENCH GUIANA: 1 ♀, 1 ♂, Mana River, June 1917 (CM, Pittsburgh); 1 ♀, St Jean de Maroni; 1 ♀, 'Nouveau Chantier'; 1 ♀, Charvein (MNHN, Paris); 1 ♀, Les Hattes, Bas Maroni (*Le Moult*) (Menke coll.); 1 ♂ 'Laiord' [?] (MNHU, Berlin); 1 ♀ (*Ballion*) (IRSNB, Brussels); 1 ♀ without further data (UZM, Copenhagen); 1 ♂ without further data (IRSNB, Brussels). BRAZIL: 1 ♀, Pará, Belém, 1846 (*Ghiliani*) (MIZSU, Turin); 1 ♀, Pará, Belém, 8.vii.1902 (*Ducke*) (MP, Belém); 1 ♀, no locality (*Ballion*) (IRSNB, Brussels); 1 ♀, 1 ♂, without data (NM, Vienna); 2 ♂ without data (FSAE, Gembloux).

Trigonopsis cyclocephalus Smith

(Figs 22, 23, 38, 39, 64, 66, 89, 90, 101)

Trigonopsis cyclocephalus Smith, 1873 : 54. Holotype ♂, BRAZIL (BMNH) [examined].
[*Podium* (*Trigonopsis*) *affine* Smith; Kohl, 1902 : 34, part. Misidentification.]
Trigonopsis cyclocephalus Smith; Menke *in* Bohart & Menke, 1976 : 98.

♀. BL 20–22. Mandible very stout, the base slightly curved and parallel-sided almost to the notch, where it is strongly curved. Near the notch, the upper margin of the base is very narrowly inflexed, that of the apex broadly. Notch large, right-angled to obtuse distally, more obtuse proximally, and partly overhung by a strong carina. Outermost pair of clypeal teeth large, well-formed, strongly bent forwards, sometimes notched near the base of the outer side, but the tips not bent back. Between them are usually 4 much smaller and often irregular teeth with a wide central gap, but occasionally a short but very broad seventh tooth fills the latter; some teeth may be fused, occasionally asymmetrically. (Figs 22, 23.) Pronotum with sharply angulate dorsal projection. Gaster red. HW 4·3–4·5, HL 3·3–3·6, HR 1·2–1·3, EL 2·4–2·6, UIW 1·9–2·1, MIW 2·4–2·6, LIW 2·2–2·4, CTW 1·4–1·5, TOD 0·6–0·8, CR 1·7–2·5, MBL 2·5–2·8, MAL 0·8–1·1, MR 2·4–3·3, PDL 2·5–2·6, PL 2·4–2·8, PR 1·0–1·1.

♂. BL 15–19. Clypeus with the 2 teeth narrowly spaced (Fig. 64). Third antennal segment 1·1–1·3 long, 1·8–1·9 times as long as the first. Sternite 8 with rather sharp keel near the tip, which is narrowly truncate (Fig. 66). HW 3·1–3·7, HL 2·8–3·2, HR 1·1–1·2, EL 1·8–2·3, UIW 1·6–1·8, MIW 1·9–2·2, LIW 1·6–1·9, CTW 0·35–0·40, CED 0·35–0·40, CER 0·9–1·1, TOD 0·85–0·97, CR 0·4–0·5, PDL 1·8–2·2, PL 2·3–3·0, PR 1·2–1·4. Otherwise as female.

The female is very similar to that of *intermedia*, but has a mandibular spine. The male is extremely similar externally to those of *moraballi* and *cooperi*. However, *cooperi* is easily distinguished by its genitalia, while the differences between those of *moraballi* and *cyclocephalus* are numerous but slight. See keys (p. 129).

THE NON-TYPE SPECIMENS. The males from Leticia reared by Cooper differ from the holotype male in that they are smaller, their temples less expanded and their genitalia slightly different. However, I feel that they are better placed with *cyclocephalus* than with *moraballi*. The identification of female *cyclocephalus* as here treated is based largely on this reared material.

VARIATION. Back of male head ± strongly expanded. Female clypeal teeth irregular as detailed above.

DISTRIBUTION. So far known only from the Upper Amazon (map, Fig. 101).

BIOLOGY. Two mud nests, each of four cells, were found by Cooper at Leticia on 31.viii.1974, 7·6 cm apart, under a flattened liana. One cell of the first was filled with cockroaches (Blaberidae, 1 ♀ *Poroblatta* or gen. near, perhaps n. sp. (det. Gurney)), a second contained a full-grown larva, and the remainder, pupae. The other nest had an entirely smooth surface, i.e. the cells had a complete, overall covering. It measured 750 mm long by 350 mm wide and was roughly oval in shape, but distinctly smaller at one end [perhaps with male cells ?]. Both sexes were reared from these nests. Cooper found two other nests at La Chorrera, Colombia. The first, on 25.viii.1976, consisted of a single cell 270 mm by 170 mm, with a rough surface, under a leaf 2·5 m from the ground. A male wasp was reared. The second nest, on 28.viii.1976, had two cells, measured 40 × 35 × 15 mm, and had a smooth surface. It was under a leaf 2 m from the ground. The first cell contained a larva which failed to develop, the second was still being provisioned by a female, which was captured. The cockroaches were 1 ♂, 1 ♀, of the same species as those from the Leticia nest (det. Gurney).

Cooper informs me that all the cocoons of *cyclocephalus* he found resembled those in Figs 38, 39.

MATERIAL EXAMINED. Holotype ♂, BRAZIL: Amazonas, Tefé (*Bates*) (BMNH).

BRAZIL: 1 ♀, Amazonas, São Paulo de Olivença (UM, Oxford); 1 ♀, same locality (*Bates*) (ZSBS, Munich); 2 ♀, Amazonas, Tabatinga, 7 & 8–9.viii.1974 (*Cooper*) (BMNH). COLOMBIA: 1 ♀, Amazonas, Leticia, 19–20.viii.1974; 3 ♀, 2 ♂, same locality, 31.viii.1974, reared (*Cooper*); 1 ♂, Amazonas, Rio Igara Paraná, La Chorrera, 25.viii.1976, reared (*Cooper*); 1 ♀, same data but not reared; 1 ♀, same data but 28.viii.1976, not reared (BMNH).

Trigonopsis moraballi Richards

(Figs 12, 13, 61, 67, 91, 92, 101)

Trigonopsis moraballi Richards, 1937 : 107, 112. Holotype ♀, GUYANA (BMNH) [examined].

♀. BL 19–21. Mandible very stout, parallel-sided and straight almost to the notch, where it is very strongly curved. Apex very slender, upper margin broadly inflexed, especially near the notch, but that of the base not at all so. Notch large, right-angled or acute distally, rounded proximally, not overhung by a carina.

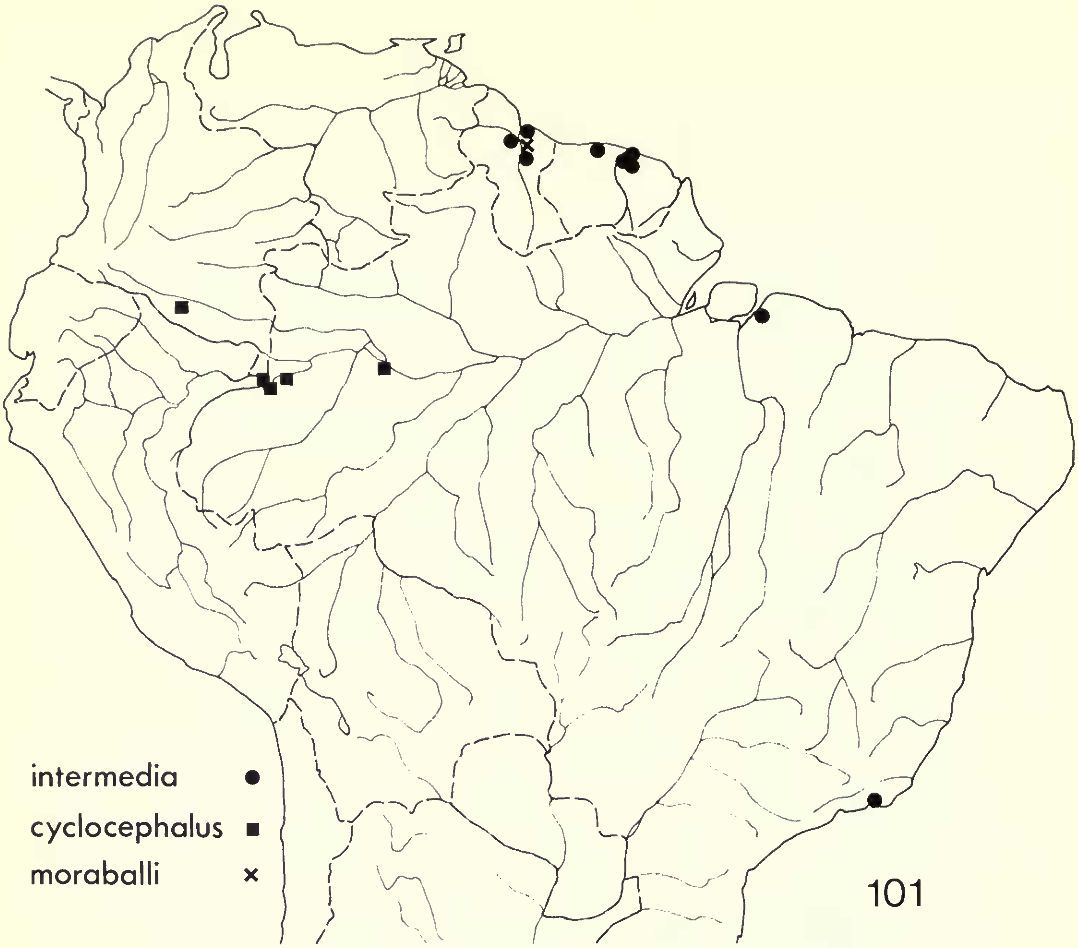


Fig. 101 Collection localities of the *T. intermedia*-group.

The large, outermost pair of clypeal teeth strongly bent forward, tips slightly bent back, notched on outer side near tip. Between them are 4 smaller teeth, fairly regular in height and spacing, but centre pair more obtuse, sometimes slightly shorter and closer together (Fig. 12). HW 4·1–4·2, HL 3·2–3·3, HR 1·2–1·3, EL 2·3–2·4, UIW 1·9–2·0, MIW 2·3–2·5, LIW 2·0–2·1, CTW 1·2–1·3, TOD 0·5–0·6, CR 2·1–2·4, MBL 2·3–2·5, MAL 0·5–0·8, MR 2·9–3·1 (–4·4), PDL 2·1–2·2, PL 2·4–2·6, PR 1·1–1·2.

♂. BL 16. Clypeus with the 2 teeth narrowly spaced (Fig. 61). Third antennal segment 1·0 long, 1·6 times as long as the first, MIW 0·35 more than UIW. Sternite 8 with moderately sharp keel, its tip broadly rounded (Fig. 67). Genitalia as in Figs 91, 92. HW 3·2, HL 2·8, HR 1·1, EL 2·0, UIW 1·6, MIW 2·0, LIW 1·5, CTW 0·35, CED 0·32, CER 1·0, TOD 0·70, CR 0·4, PDL 1·7–1·8, PL 2·4–2·5, PR 1·4. Otherwise as female.

The female is rather like those of *intermedia* and *cyclocephalus*, but its mandibular notch lacks an overhanging carina and the clypeal teeth are less irregular.

The male is extremely similar externally to those of *cooperi* and *cyclocephalus*. However, *cooperi* has distinct genitalia, while the differences between those of *moraballi* and *cyclocephalus* are numerous but slight (see keys p. 130).

Variation. In the single female without locality the 2 centre teeth are much shorter than the adjacent pair, one of them is displaced outwards and the larger gap thus created has a blunt, vestigial seventh tooth (Fig. 13). These differences suggest that this specimen may not belong to *moraballi*, but in the absence of other evidence it seems best to regard it as representing variation within the species.

DISTRIBUTION. So far known only from Guyana, but the much paler colour of the specimen without data suggests the possibility of an Upper Amazon origin (map, Fig. 101).

BIOLOGY. Richards (1937 : 108–109) gives a photograph of a 2-celled nest and notes on others. He states that they were found under leaves, 1·2–1·8 m from the ground. Each of the mud cells had one end touching the leaf mid-rib. There was a maximum of 3 cells per nest, the cells being parallel to and in contact with each other. Cockroaches were used as prey, and a wasp was seen to carry one with its 'mouth and forelegs'. A bombyliid fly, *Anthrax leucopyga* Macquart, was also reared.

MATERIAL EXAMINED. Holotype ♀, GUYANA: Essequibo River, Moraballi Creek (*c*. 30 km SE. Bartica), 2.ix.1929, reared (*Oxford University Expedition*) (BMNH).

GUYANA: 1 ♀, same data as holotype; 1 ♀, same data except 3.x.1929, not reared; 2 ♂, same data except 13.viii.1929, not reared, and 20.ix.1929, reared (BMNH) (all paratypes of *moraballi*). 1 ♀ without data (UM, Oxford).

The *neotropica*-group

All species are uniquely characterized by: female mandibular notch formed by a step-like thickening, and cuspis of male genitalia with apex of basal post truncate. Further characters are: pronotum with dorsal projection, propodeum with dorsal rugae also outside central furrow, female clypeus with 5 teeth.

Within the group, *cooperi* is distinguished by: slender female mandible, notch vestigial (never absent), and cylindrical male antennae. The remaining species are further united by: males with antennal segments slightly flattened, and offset at their junctions, females with identical mandibular shape unique to this group: rather stout, slightly curved towards tip, inner margin slightly expanded before notch. The females of two species are still further united by: outermost pair of clypeal teeth equal to or slightly shorter than adjacent pair, another character unique to this species-group.

Rugae outside central furrow of propodeal dorsum often markedly obsolescent anteriorly, especially in *succinea* and *cooperi*.

The evidence so far available suggests that the species of this group, unlike the others in the genus, add no extra mud to the nest after the cells are complete. It is curious that, despite this, extreme mandibular wear is found in an unexpectedly high proportion of females (see also *succinea* biology).

Trigonopsis neotropica sp. n.

(Figs 18–20, 27, 54, 85, 86, 102)

[*Trigonopsis cyclocephalus* Smith; Richards, 1937 : 107, putative ♀. Misidentification.]

♀. BL 19–20. Mandible stout, inner margin of base a little expanded before the step-like notch. Small, basal spine of mandibular inner margin narrow, pointed (Fig. 18). Clypeal teeth ± bent forwards, the outermost pair most strongly, often slightly broader and more blunt than adjacent pair. Centre tooth smaller than others. Centre pair of gaps a little narrower than outer (Figs 18–20). Occipital carina often ± expanded into a brown, translucent lamellar flange. Pronotal dorsal projection scarcely concave anteriorly (Fig. 27). Wings not amber-tinted, stigma and most veins dark brown. HW 3·7–3·9, HL 3·2–3·5, HR 1·1–1·2, EL 2·2–2·4, UIW 1·7–1·8, MIW 2·1–2·3, LIW 1·8–2·0, CTW 1·2–1·4, TOD 0·45–0·50, CR 2·7–2·9, MBL 2·0–2·2, MAL (0·25–) 0·45–0·60, MR 3·3–4·4 (–8·4), PDL 2·2–2·4, PL 2·9–3·2, PR 1·2–1·4.

♂. BL 18. Clypeus with 2 large, sharp teeth. Base of outer side of each tooth is tuberculate behind. Behind tooth-to-orbit margin but not forming part of it, is another tubercle whose tip is just visible in front view. Together with the other, it forms the sides of a deep notch. There is no third tubercle behind the outer one (Fig. 54). Clypeus similar to that of male *vicina* (Fig. 60). Inner orbits parallel. Antennal segments slightly flattened dorsoventrally, their junctions offset in lateral view (cf. Fig. 59). Occipital fossa width 1·5. Genitalia as in Figs 85, 86. HW 3·6, HL 3·3, HR 1·1, EL 2·2, UIW 1·8, MIW 2·1, LIW 1·8, CTW 0·65, CED 0·45, CER 1·4, TOD 0·82, CR 0·8, PDL 2·1, PL 2·9, PR 1·4. Otherwise as female.

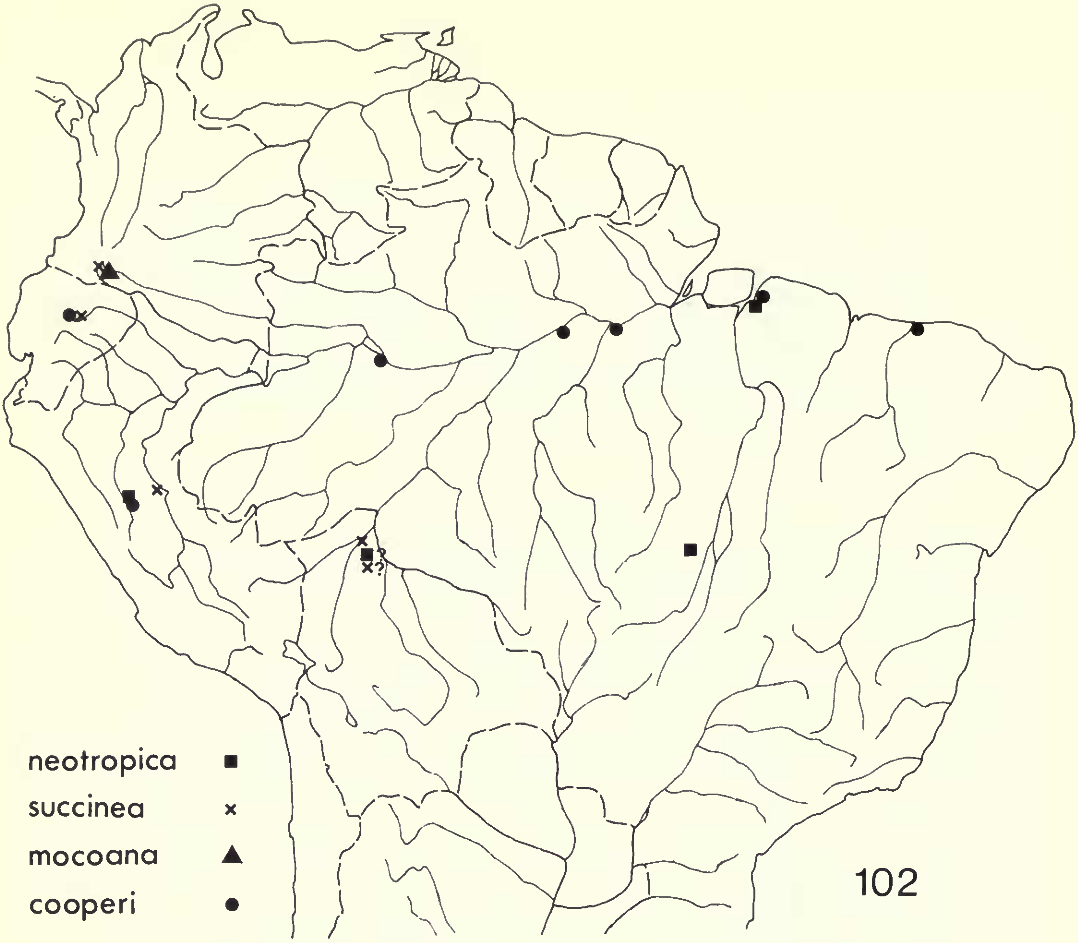


Fig. 102 Collection localities of the *T. neotropica*-group.

The female is similar to that of *succinea*, but is distinguished by its smaller size, the basal spine of the mandibular inner margin pointed instead of rounded, shorter petiole, less coarse propodeal sculpture etc. The male is very like that of *vicina*, but lacks the antennal expansions.

Variation. The Belém (i.e. easternmost) specimens differ from the others in the following ways.

The body is altogether darker, in particular the clypeus, legs and wing-bands.

The second abscissa of the radial vein is markedly shorter than the third (roughly equal in the other specimens).

In the females, the central pair of gaps between the clypeal teeth are shallower than the outer pair (Fig. 20), whereas they are roughly equal in the other females (Figs 18,19).

Although all these forms of individual variation are usually found separately in various other species of the genus, it is interesting that they occur together, as well as being geographically correlated, in *neotropica*.

Distribution. Widespread but uncommon (map, Fig. 102).

Biology. The paratype female bears a label 'From one of 3 clay cells fastened side by side under arboreal termites nest. One cell already vacated and one pupa broken in fall.' Hamilton further informs me that the nest was about 5 m from the ground, and that the individual cells were visible.

If this is a typical nesting-site for the species-group (excepting the aberrant species *cooperi*) they may build their nests at a much greater height than other *Trigonopsis*. This would help to explain why it is much the rarest species-group in collections (see also *succinea* biology).

MATERIAL EXAMINED. Holotype ♀, BOLIVIA (*Steinbach*) (BMNH) (Richards' putative *cyclocephalus* ♀).

Paratypes. PERU: 1 ♀, Huánuco, Tingo Maria, 20–27.i.1968 (*Garcia & Porter*) (MCZ, Harvard). BRAZIL: 1 ♀, Mato Grosso, Serra Roncador, Royal Society Base Camp, 12.50 S., 51.47 W., 11.vi.1968, reared (*Hamilton*) (BMNH); 1 ♀, 1 ♂, Pará, Belém, 6.iii.1900 (*Ducke*) (NM, Vienna); 1 ♀, Pará, Belém, 30.vi.1900 (*Ducke*) (MP, Belém).

Trigonopsis succinea sp. n.

(Figs 24, 25, 28, 53, 59, 95, 96, 102)

♀. BL 22–26. Mandibular base with inner margin a little expanded before the step-like notch. Small basal spine of mandibular inner margin rather broad, rounded at tip. Outermost pair of clypeal teeth scarcely shorter but ± broader and blunter than adjacent pair. Centre tooth equal to or shorter than outermost pair. Teeth ± asymmetrical. Centre pair of gaps wider and deeper than outer pair. Lower part of clypeus and teeth a little bent forward (Figs 24, 25). Occipital carina slightly lamellar flange-like, black, translucent only when seen against the light. Pronotum with dorsal projection strongly transverse, in profile very strong and sharply angulate with distinct concavity in front (Fig. 28). Pubescence of anterior half of mesoscutum ± dense. Wings ± strongly amber-tinted, stigma pale (much paler than infuscation of radial cell). Rugae outside central furrow of propodeal dorsum very coarse, rather widely spaced, and usually strongly obsolescent anteriorly. Central groove very deep throughout. HW 3·8–4·6, HL 3·5–4·0, HR 1·1–1·2, EL 2·3–2·7, UIW 1·8–2·1, MIW 2·2–2·6, LIW 1·9–2·3, CTW 1·1–1·4, TOD 0·6–0·7, CR 1·8–2·2, MBL 2·1–2·5, MAL 0·45–0·80, MR 2·8–4·4 (–4·9), PDL 2·5–3·1, PL 3·7–4·4, PR 1·3–1·5.

♂. BL 17–20. Clypeus with two large, sharp teeth. Tooth-to-orbit margin entire, without tubercles (Fig. 53). Antennal segments slightly dorsoventrally flattened, their junctions offset in lateral view (Fig. 59). Head ± expanded posteriorly. Genitalia Figs 95, 96. HW 3·3–3·8, HL 3·0–3·5, HR 1·1, EL 2·0–2·2, UIW 1·7–2·1, MIW 1·9–2·2, LIW 1·6–1·8, CTW 0·37–0·60, CED 0·30–0·47, CER 1·2–1·3, TOD 0·77–0·87, CR 0·5–0·7, PDL 2·0–2·4, PL 2·7–3·8, PR 1·3–1·6. Otherwise as female, except occipital carina narrower.

The female is similar to that of *neotropica*, but the basal spine of the mandibular inner margin is rounded instead of sharp, the insect is larger, has a longer petiole, coarser propodeal sculpture, etc. At first sight the male much resembles those of several other species, but has slightly flattened antennae. The identification should always be confirmed by genitalia examination (Figs 95, 96).

VARIATION. Female clypeal teeth as detailed above. The back of the head of the male from Tena is very strongly expanded, that of the one from Riberalta scarcely so.

DISTRIBUTION. East Andean foothills from Colombia to Bolivia. Most records are from about 600 m, with isolated ones down to about 200 m (map, Fig. 102).

BIOLOGY. Cooper has observed females collecting various kinds of mud (on one occasion in the company of a *rufiventris* female). All of them flew high into the forest, which strengthens the supposition (discussed under *neotropica*) that most species of this group build their nests far above the ground.

Cooper informs me that the females especially of this species emit an offensive smell when captured.

MATERIAL EXAMINED. Holotype ♀, ECUADOR: Napo, Tena, 14.iv.1976 (*Cooper*) (BMNH).

Paratypes. ECUADOR: 2 ♀, same data as holotype but 16 & 19.iv.1976 (BMNH); 1 ♂, Napo, near Tena, v.1923 (*Williams*) (BPBM, Honolulu). COLOMBIA: 2 ♀, Putumayo, Mocoa, 580 m, 31.iii., 2.vi.1976 (*Cooper*) (BMNH); 1 ♀, same data but 5.vi.1976 (USNM, Washington). PERU: 1 ♀, Loreto, Pucallpa, 14.ii.1952 (*Schunke*) (BMNH). BOLIVIA: 1 ♀, 'Songo' (TM, Budapest); 1 ♂, Beni ('Pando' on label), Riberalta, xi,1956 (*Fritz*) (Fritz coll.).

Trigonopsis mocoana sp. n.

(Figs 35, 102)

♀. BL 18–20. Mandible stout, inner margin of base a little expanded before the notch, which is step-like and very small (but not vestigial as in *cooperi*). Outermost pair of clypeal teeth the longest. Centre tooth slightly shorter than adjacent pair, and about half height of outermost pair and narrower than them. All teeth bent forward, outermost pair most strongly. All gaps are equally deep but centre pair slightly narrower than outer pair (Fig. 35). Pronotal dorsum with sharply angulate projection. Pubescence moderately dense on anterior half of mesoscutum. Gaster red. HW 3·6–3·8, HL 3·0–3·2, HR 1·2, EL 2·2–2·3, UIW 1·7, MIW 2·1–2·2, LIW 1·7–1·8, CTW 0·9–1·0, TOD 0·6–0·7, CR 1·3–1·7, MBL 1·9–2·0, MAL 0·5–0·6, MR 3·4–3·8, PDL 2·2–2·4, PL 2·5–2·6, PR 1·1.

♂. Unknown.

The female is rather like that of *cooperi*, but is distinguished by the mandible having a larger notch, with the inner margin expanded before it; and by the smaller clypeal ratio.

VARIATION. Slight irregularity in female clypeal teeth.

DISTRIBUTION. Known only from the one locality (map, Fig. 102).

BIOLOGY. Unknown.

MATERIAL EXAMINED. Holotype ♀, COLOMBIA: Putumayo, Mocoa, 24.xii.1974 (*Cooper*) (BMNH). Paratype. 1 ♀, same data as holotype but 6.iv.1976 (BMNH).

Trigonopsis cooperi sp. n.

(Figs 33, 34, 65, 68, 93, 94, 102)

[*Trigonopsis affinis* Smith, 1851 : 31, ♀, part. Misidentification.]
[*Trigonopsis moraballi* Richards, 1937 : 107, ♂, part. Misidentification.]
[*Trigonopsis cyclocephalus* Smith; Richards, 1937 : 107, ♂, part. Misidentification.]

♀. BL 17–19. Mandible rather slender, almost parallel-sided and scarcely curved, more strongly so around the notch. Notch vestigial (never absent), formed by a dent in upper edge of mandible. Below it on the inner side is a small thickening, forming a step in the longitudinal carina present there. Sometimes the two structures join to form a broader step, as in the other species of the group, but smaller. Clypeal teeth well formed and regular, the outermost pair the longest. Three centre teeth often equal, but middle one variable. Tooth-bearing area of clypeus not very projecting, only outermost pair of teeth bent forwards, contrasting with others. A ± broad and translucent lamella connects outermost clypeal tooth with lower orbit. Head very broad, Figs 33, 34. HW 3·5–4·0, HL 2·7–3·1, HR 1·2–1·3, EL 2·0–2·3, UIW 1·7–1·9, MIW 1·9–2·3, LIW 1·7–1·9, CTW 0·9–1·1, TOD 0·4–0·6, CR 1·8–2·7, MBL 2·0–2·3, MAL 0·3–0·6, MR 3·6–5·5 (–7·3), PDL 1·9–2·3, PL 2·4–2·7, PR 1·0–1·4.

♂. BL 16–17. Clypeus with two large, sharp teeth, tooth-to-orbit margin entire (Fig. 65). Antennal segments cylindrical, the third 0·9–1·0 long, 1·5–1·6 times as long as the first, MIW 0·15–0·20 more than UIW. Sternite 8 with obtuse keel, tip narrowly rounded (Fig. 68). Genitalia as in Figs 93, 94. HW 3·1–3·3, HL 2·8–2·9, HR 1·1–1·2, EL 1·9–2·0, UIW 1·6–1·7, MIW 1·8–1·9, LIW 1·4–1·5, CTW 0·30–0·32, CED 0·27–0·30, CER 1·0–1·1, TOD 0·72–0·77, CR 0·4, PDL 1·8–1·9, PL 2·6, PR 1·4. Otherwise as female.

The female is like that of *mocoana*, but distinguished by the mandible having a smaller notch (sometimes vestigial) and lacking an expansion before it; and by the greater clypeal ratio. Externally, the male is extremely similar to those of *cyclocephalus* and *moraballi*, differing mainly in its genitalia.

VARIATION. The female clypeus shows geographical variation. In the east, the teeth tend to be sharper and the lamella less developed (Fig. 33), while in the west, the teeth tend to be more rounded, and the lamella broader and ± translucent. These are most pronounced in the Tena specimens, in which the roundness of the teeth cannot be due to wear since two of the specimens were reared (Fig. 34).

The propodeal dorsal rugae outside the central furrow also vary, in both sexes. They are strongly obsolescent anteriorly in most specimens, but in those from the east they tend to be less coarse, and moderately obsolescent also posteriorly.

DISTRIBUTION. The Amazon, from Tena to Belém; also Piauí and Tingo Maria (map, Fig. 102).

BIOLOGY. Cooper found a nest at Tena, Ecuador under a leaf 1·7 m from the ground. It consisted of 4 mud cells in a row, the sides in contact but without an overall covering, so that the individual cells were plainly visible. The first cell was empty, with an emergence hole. The second was empty but without a hole. The third contained a female wasp about to emerge. Another female was later taken from cell four. This last cell (preserved in BMNH) measures about 23 mm long × 14 mm across and has a rough surface, showing the outlines of the individual blobs of mud composing it. Also extracted from this cell were the remains of three cockroach nymphs of the family Blaberidae (det. J. A. Marshall). The Tena 17–19.xii female was starting to build a nest under a leaf, about 18 ins from the ground.

MATERIAL EXAMINED. Holotype ♀, ECUADOR: Napo, Tena, 9–14.xii.1971, reared (*Cooper*) (BMNH).

Paratypes. ECUADOR: 1 ♀, same data as holotype; 1 ♀, same data except 17–19.xii.1971 (not reared) (BMNH). PERU: 1 ♀, Huánuco, Tingo Maria, 16.x.1946, 2,200 ft (*Pallister*) (AMNH, New York). BRAZIL: 1 ♀, Pará, Santarém (*Wallace & Bates*) (paralectotype of *affinis*); 1 ♀, Pará, Belém (both UM, Oxford); 1 ♀, Pará, Belém, 1846 (*Ghiliani*) (MIZSU, Turin); 1 ♂, Pará, Belém, ix–x.1959 (*Bianchi*) (BPBM, Honolulu); 1 ♂, Pará, Santarém (*Bates*) (paratype of *moraballi*) (BMNH); 1 ♀, Piauí (TM, Budapest); 1 ♀, Amazonas, Tefé (*Bates*) (ZSBS, Munich); 1 ♂, Amazonas, Villa Nova (*Bates*) (det. as *cyclocephalus* by Richards) (BMNH); 1 ♀, Pará, Belém, Mocambo, 6.viii.1970 (*Pimentel*); 1 ♀, Pará, Ilha das Onças, 30.i.1977 (*Overal*) (both MP, Belém); 1 ♀, Ilha das Onças, 22.i.1977 (*Overal*) (BMNH).

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Index

Junior synonyms and other invalid names are in *italics*.